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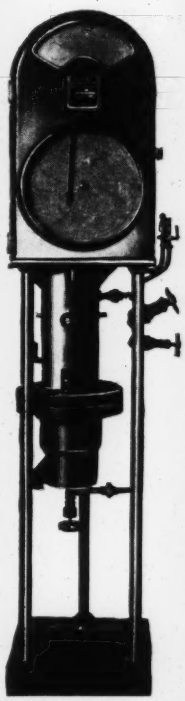

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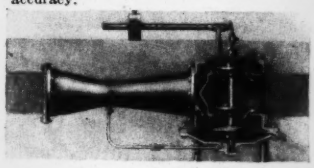

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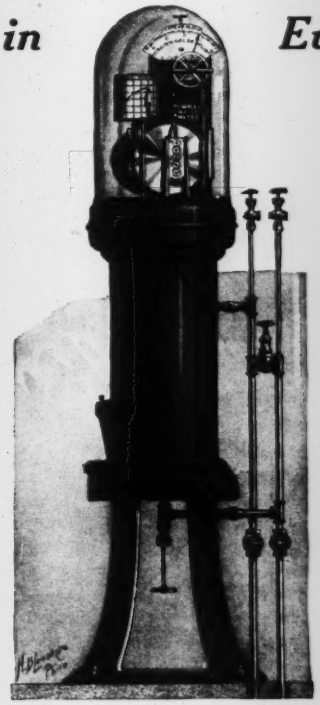

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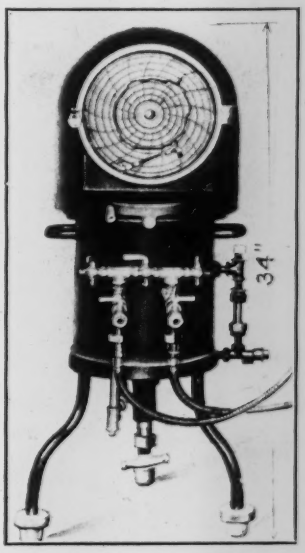

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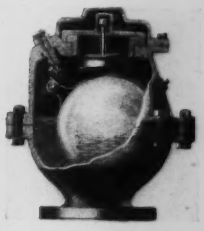

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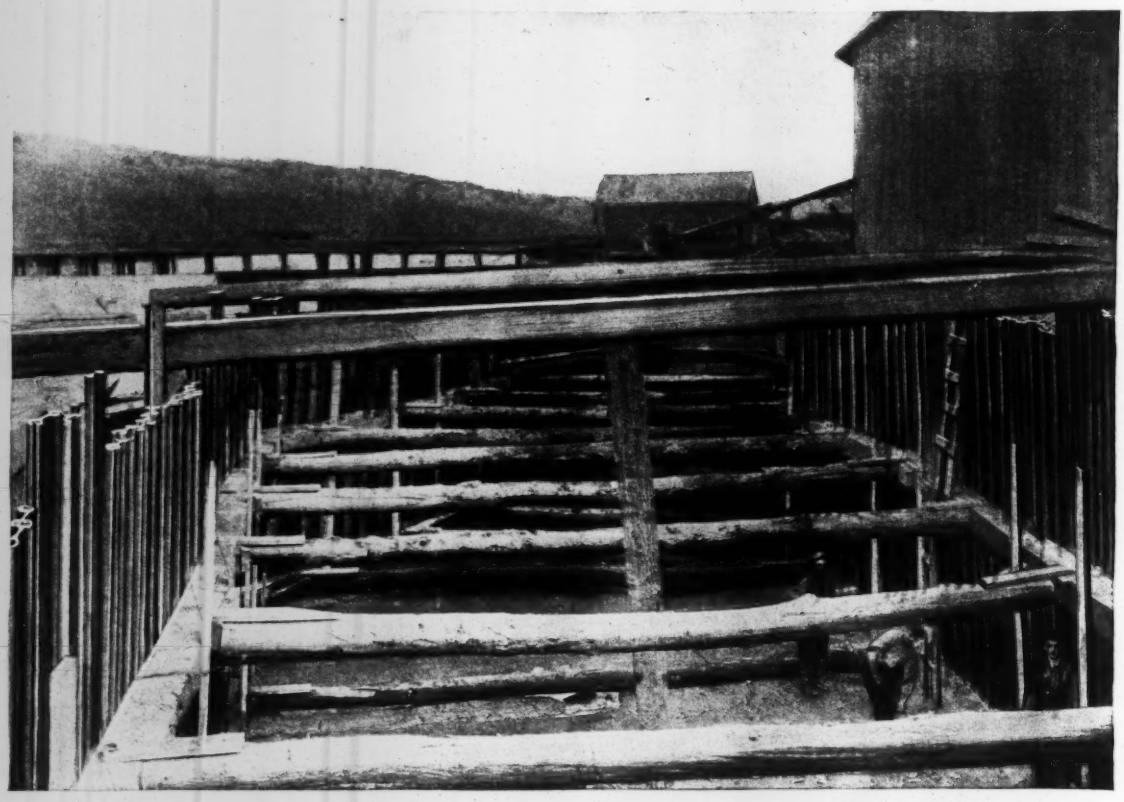

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Engineering News

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Chicago Has New Shop Plant for All Public Works

By C. C. Saner*

SYNOPSIS—The City of Chicago has consolidated the shops of its water, sewer, fire, police and other service departments and built a modern industrial plant having machine, carpenter and paint shops, foundry, administration building, garage, storehouse and storage yards. The manufacture of new water-works supplies forms a large item in the plant's work. Layout of the new works and general equipment of the several shops are described.

As the City of Chicago has annexed territory from time to time, various local fire, police, sewer and water departments have been amalgamated with the existing city departments, and these last have grown also with the increase in population of the original city. A greater and greater amount of repair and construction work has had to be done, and increasing quantities of supplies have had to be stored for the various public departments. The departments have established shops and warehouses from time to time as their individual needs have demanded, but these have been scattered about the city in any building the city happened to own or could conveniently rent. The structures have been old, poorly lighted and insanitary, and showed serious fire hazards. Valuable patterns, like those for pumping-engine and bridge-machinery parts, were stored where, if a fire had once started, it could not have been stopped before the loss would have been irreparable. No attempt was made until recently to standardize the great amount of supplies bought by the various departments.

Such inefficiency in public works is not due in any large measure to graft and corruption. The city has only been in the same position as some of the country's great industries. In order to give service to their customers at all they have had to perform many operations in an inefficient manner. After the service requirements have been met, the industries have built modern plants and stopped the leaks in manufacturing processes. Where the growth of a city like Chicago has been rapid, the problem of government has been difficult. Many times efficiency has had to be entirely disregarded in order to maintain public service. Bringing the service in new territory up to the older standards has required time, effort and expense. The assembling of the shops and warehouses of all the public-works departments in a modern industrial plant is but one of the final steps of the development of the government.

FIG. 1. GENERAL VIEW OF CHICAGO MUNICIPAL SHOPS UNDER CONSTRUCTION
From left to right—Machine shop, foundry, carpenter shop and warehouse

In 1913 the city had the service problem in hand well enough to start a comprehensive plan for the consolidation of the various shops and warehouses. Thirty acres of land at 31st St. and Sacramento Ave. was purchased for the construction of a modern plant.

A careful study was made of the shops of the water, police and fire departments, of the various warehouses and of the records stored in the vaults of the City Hall. After these surveys had been completed, the general plan and size of buildings were determined and construction work was started, in the spring of 1914.

*Designing Engineer, Department of Public Works, Chicago.

As the city manufactures all its fire hydrants and valves up to 12 in. in diameter, the plan had to be so made that the work would progress in an orderly manner from the pattern shop through the foundry and machine shop to the warehouse and storage yards. Provision had to be made to store all patterns, supplies of all kinds and public records. The machine shop had to be erected so as not only to manufacture hydrants and valves, but also to repair all kinds of pumping machinery, fire and police equipment and construction machinery. Fig. 2 shows the general layout of the complete plant, as finally made.

The foundry was completed and placed in operation in August, 1915, and is now supplying all castings for the city except straight cast-iron pipe. All manhole curbs and covers, special water-pipe castings, hydrant and valve castings are made here. The castings are made and delivered at market prices, and it may be safely stated that the castings are of a better quality than can be bought. Inspection of materials is maintained here the same as it would be maintained on an outside contract, except that there is not a continual disagreement between the inspectors and the contractors. Fig. 3 shows an interior view of the foundry before operation was started. The iron-molding room is equipped with two traveling cranes. One is of 5-ton capacity, and the other of 10 tons with a 3-ton auxiliary hoist. The flask yard and the iron yard each have a traveling crane of 5 tons' capacity. The cupola is of 10-ton capacity. No device for the most efficient operation of a foundry has been omitted, and the operating costs bear out the wisdom of the policy.

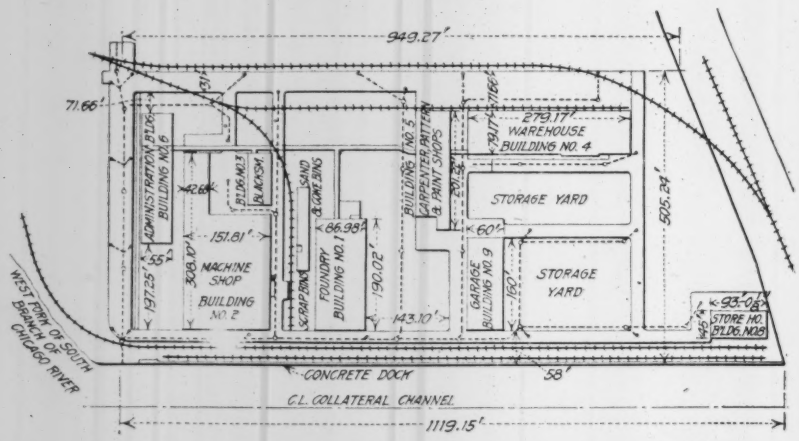

FIG. 2. GENERAL PLAN OF NEW CHICAGO MUNICIPAL SHOPS

The machine and blacksmith shops were placed in operation in May, 1916, and results of operation in the new plant as compared with the old will not be available for some time. The machine shop consists of the main shop and a two-story north and south wing. The blacksmith shop is an extension of the south wing with one bay omitted. The north wing is extended the same number of bays as the south wing; and when more room is required, the space between will be roofed over and the omitted bay built in, giving a shop 308 ft. long. The south wing of the machine shop is assigned to the small machine tools for manufacturing hydrants and valves and to the toolroom. The north bay is assigned to the repair of fire and police equipment of all kinds, a supply room and an assembly room for hydrants and valves. The main shop contains the large machine tools and has available room for concrete mixers, road rollers, ditching machines, etc., undergoing repairs. The second floor of the south wing is assigned to the water-meter repairing and testing division. The second floor of the north bay is unassigned as yet.

The main shop is equipped with a 25-ton traveling crane having a 5-ton auxiliary hoist. Jib cranes are placed at convenient locations for handling castings to the machines. The blacksmith shop is equipped with nine down-draft forges, a steam and power hammer and a jib crane operating in full circle. The foundry, machine and blacksmith shops are of steel construction with brick walls, steel window and door frames and wire-glass windows.

The carpenter-, paint- and pattern-shop building and the warehouse are of the same type of construction. Both have four stories and a basement and are on caisson foundations. The frame is of reinforced concrete with brick curtain walls, steel window and door frames and wire-glass windows. Both buildings are equipped throughout with automatic sprinklers. The carpenter-, paint- and pattern-shop building will contain also steam fitters', sheet-metal workers' and harness shops and the pattern-storage rooms. The warehouse floors are unassigned; supplies and records will be stored as they are received.

The administration building, now under construction, will contain the offices for the general supervision of the plant, an electric-power transformer room, a dining room and kitchen, all on the main floor, and testing laboratories on the second floor.

The power house will be inside the grounds of the House of Correction, just across the west fork of the south branch of the river. All piping and wires will be carried through tunnels to the various buildings. The power house will be operated with convict labor, so that power will be furnished at less than 1c. per kw.-hr., and heat will be at the same relative cost. This power house will furnish, in addition, heat, light and power to the new city contagious-disease hospital, which is located on the east end of the new property, and to the buildings of the House of Correction.

A garage with a capacity of 40 machines has been constructed west of the warehouse. Eighteen trucks are now used by the Division of Pipe, Yards and Stores, all of which will operate from this garage. Under the east end of the garage a basement has been constructed in which are two 10,000-gal. oil tanks for storing engine and cylinder oil, and smaller tanks for other lubricating oils, while buried in the ground just outside are a 12,000-gal. tank for gasoline, a 1,000-gal. tank for kerosene and a 500-gal. tank for turpentine. These large tanks have pipe lines running to the switch track at the west of the garage for unloading tank-cars.

The yard for storing special castings will be paved with concrete on the same grade as the roads, no curb extending above the pavements. This provision is made to allow electric elevating-platform trucks to run into

the yard with castings and place them. Castings will not be removed from the platforms on which they are transported, but will remain on them until they are removed for shipment from the yard.

Derricks will not be provided in the special-casting yard, as it is planned to gather all materials for truck delivery on a loading platform on the west side of the ware-

FIG. 3. IN THE CHICAGO CITY FOUNDRY

house. By collecting all materials for truck delivery in this way, trucks will be able to load and leave the plant in a minimum amount of time.

A concrete dock has been constructed along the collateral channel of the drainage canal, west of the plant. This dock will provide a way for fireboats, tugs, scows and other craft to lie adjacent to the shops for repairs.

FIG. 4. IN THE CHICAGO CITY MACHINE SHOP

All building has been done by day labor under the direct supervision of W. H. Dean, Assistant Engineer, working under H. W. Clausen, Engineer of Water-Works Construction. Plans were made by Myron B. Reynolds, Engineer of Water-Works Design. The general scheme was evolved under John Ericson, City Engineer; Henry Allen, Consulting Mechanical Engineer; and H. S. Baker, Assistant City Engineer. The plant is estimated to cost, when complete, $1,750,000.

City-Manager Government at Phoenix Undergoes Test

EDITORIAL CORRESPONDENCE

The city-manager form of government has, in effect, undergone and is undergoing a very severe test at Phœnix, Ariz., where it has been established for nearly two years. Phœnix seems to have gained a reputation for being a hot-bed of politics, and it is doubtful if any one but an outsider could get an unbiased view of what has taken place there. The controversy between the adherents of the former city manager and those of the present holder of that office has been very bitter, and without attempting to pass on the merits of either side, a plain relation of facts and events is enlightening to those who are interested in city-manager government—and what municipal engineer is not?

The people of Phœnix adopted a new charter in 1914, which was drawn for the express purpose of "entirely eliminating politics" from the management of the city. The legislative body is a commission of five, including a mayor—elected as such to meet the requirements of the state laws. The mayor is ex-officio chairman of the commission. He receives a salary of but $300 a year, with a contingent fund of $200. The commissioners receive $5 for each meeting attended, not to exceed $300 per year. The mayor and commissioners serve for two years, but there is an election each year, alternately, for two commissioners, and for two commissioners and the mayor. The election recently held was of the latter description, so that a majority of the commission was subject to change.

The mayor and commissioners are nominated through direct primaries. Any person may enter the contest whose petition contains enough signers to equal 3% of the number of voters for mayor at the most recent election. The important offices are the city manager, city auditor, city attorney, city clerk and city treasurer. There are the usual charter provisions for initiative, referendum and recall. All other city offices are filled by appointment.

Under the original charter provisions the city manager was appointed by the commission to hold office *until removed for cause* by the commission. His salary was fixed by the charter at $5,000 per annum. The city auditor and city magistrate were the only other officers appointed by the commission. Under the original charter provisions all minor officials were appointed independently by the city manager and removed at his pleasure. Subsequent changes in these provisions and the train of events which led to them will be considered in due course.

The first city manager was a competent civil engineer, a former employee of the United States Reclamation Service. He was a "native son." As a city manager he is alleged to have been a failure from the very start. That engineers who would be city managers may profit, a recital of some of these alleged shortcomings from the point of view of a layman is of interest. He is said to have lacked dignity, to have made himself too readily accessible to anyone and every one, to have spent much of his time in the open where he could not be found when wanted on important occasions, to have allowed too many liberties of his many friends and encroachments upon his time—in short he was perhaps too good natured and affable. Such are allegations of friends and opponents.

The city manager was soon out of harmony with the majority of the commission. Whether this was due to his economies and weeding out of unnecessary city employees, as it is understood are his claims, or whether it was due to other reasons is not within the province of the writer to decide; but since there was a lack of harmony it may be presumed that there was also a lack of tact.

Things went from bad to worse so far as the city administration was concerned, until, it is alleged, conditions were far less satisfactory than under old-time politics. The commission sought to remove the manager out of hand but found the charter in the way of such a course. At length charges of incompetency were brought and a public hearing held, at which the commission was both judge and accuser. The city manager was duly discharged as incompetent. He subsequently took his case to the courts and the lower court has upheld the action of the commission.

The people were aroused at the conditions described, and to prevent a repetition of such a controversy the city charter was amended, as provided for, by popular election. The only wonder is that the voters should have continued their faith in city-manager government, and that changes were not more radical. However, these changes were enough to seriously affect the powers of the city manager.

The changes in the powers of the city manager under the original and the amended charter provisions are shown in the following columns:

ORIGINAL PROVISIONS	AMENDED PROVISIONS
The manager shall have the general supervision and direction of the administrative operation of the city government; he shall supervise and direct the official conduct of all appointive city officers, except the auditor and city magistrate; he shall supervise the performance of all contracts made by any person for work done for the city, and in that behalf represent the city, except as it may be otherwise provided in this Charter; he shall make all purchases of materials or supplies for the city and see that the same are received as contracted for; he shall employ and discharge from time to time as occasion requires all employees of the city; he shall appoint all officers of the city, the appointment or election of whom are not otherwise provided for in this Charter, and may remove them when the interests of the city require.	Section 1. Subject to the control of the Commission, the manager shall have the general supervision and direction of the administrative operation of the city government; he shall supervise and direct the official conduct of all appointive city officers except the auditor, city attorney, city clerk, city treasurer and city magistrate; he shall supervise the performance of all contracts made by any person for work done for the city, and in that behalf represent the city except as it may be otherwise provided in this Charter; he shall make all purchases of materials or supplies for the city, subject to the provisions of this Charter, and see that the same are received as contracted for; he shall employ and discharge from time to time, as occasion requires, all employees of the city appointed by him, by and with the consent and approval of the Commission; he shall appoint all officers of the city, the appointment or election of whom is not otherwise provided for in this Charter, and may remove them when the interests of the city require. Section 2. It shall be his duty, as well as that of the mayor, to see that all of the ordinances of the city are enforced.

These changes place the manager under the specific "control" of the commission so far as general administrative work is concerned; they take from the manager the appointment of the city clerk, treasurer and attorney; they make the appointment and removal of "employees" subject to approval by the commission, but appear to leave the manager independent of the commission as regards those "officers" whom he has power to appoint. Other amendments make the manager subject to removal by a three-fifths vote of the commission, and makes the manager's salary subject to the commission, instead of being fixed in the charter.

The second (and present) city manager, appointed under the revised charter, is also an engineer by education and experience. He was for a number of years connected with the former city water-works company, had responsible charge of many of the water-works improvements and is thoroughly familiar with the business management of a public utility. Fortunately for city-manager government in Phœnix his first year of the city administration has been very successful.

The city tax rate, which formerly ranged from $1 to $1.30, was this year reduced to 85c., and yet the administration will complete the fiscal year with a surplus of over $50,000. This reduction in tax rate is all the more noteworthy because there was a revenue loss of $26,000 from liquor licenses, due to state prohibition, and $28,000 loss from occupational taxes, which were abolished.

There was also a loss of revenue from a dropping off of police court fines, and there was a reduction in the assessed valuation of property to the extent of $2,000,000. Had conditions remained the same the tax rate would have been reduced to 60c.

The amount of public improvement work has remained about the same, but many economies have been effected in its performance. To mention but one there is the abolition of the city corral and the substitution of motor-driven vehicles throughout the city departments. The city corral was a well established institution for petty grafting—the renting of wornout and skinny horses to the city to be cared for and fattened at public expense. Increased efficiency of the city fire department has reduced the annual fire loss from about $200,000 to less than $25,000.

The city manager has frankly acknowledged that it has been impossible to avoid politics entirely and that he is frequently hampered in the way of appointments by members of the commission. Nevertheless he has tactfully insisted on the efficient administration of the various bureaus under him, of which the results speak for themselves. For instance, he insisted on the employment of a competent city engineer and the doubling of the salary of that office so that a competent engineer would accept it. The present city manager has no serious fault to find with the charter requirements which make him more dependent on the will of the commission. He truly says that conditions are the same as they are in every business corporation and that if the manager is out of harmony with the majority of the commission or board of directors, or lacks its confidence, it is better for all concerned that he resign.

As previously noted, the city-manager form of government is just emerging from a crucial test. At the election of the first Tuesday in April a mayor and two commissioners were elected. The former mayor and one commissioner had been very antagonistic to the city manager and in announcing his candidacy for reëlection this mayor published broadcast the statement that if he and his choice of new commissioners were elected he would clean out the present city administration and reduce the city

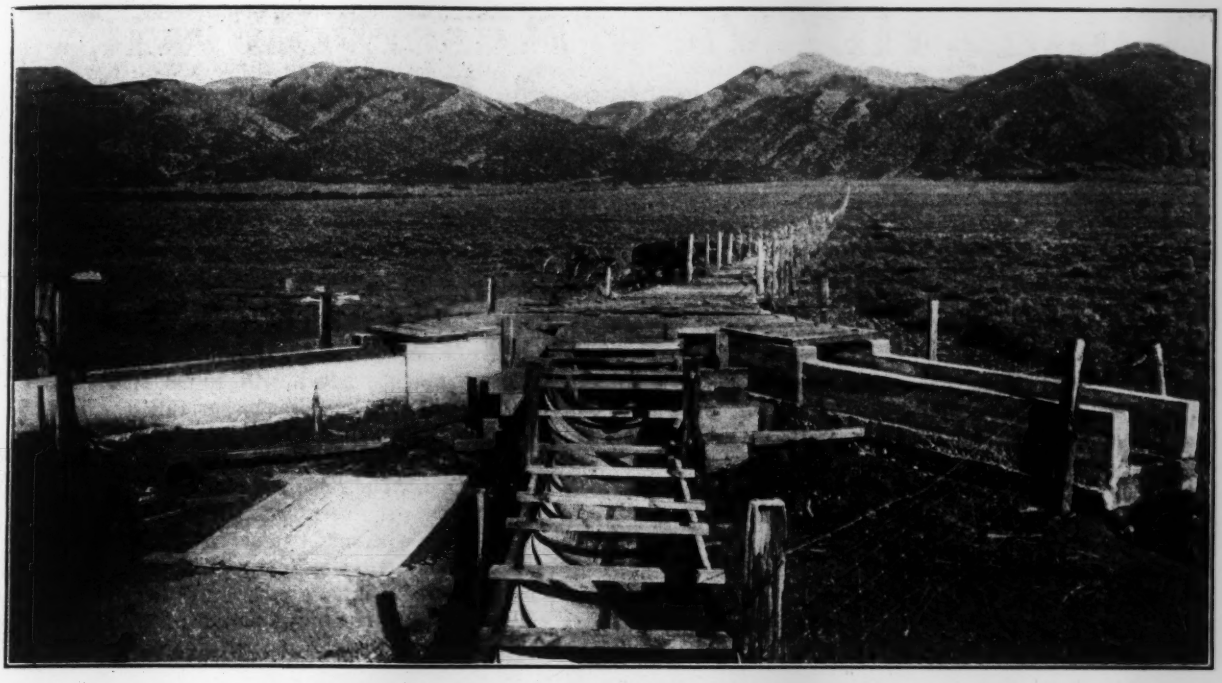

FIG. 1. THREE-WAY CONCRETE DIVERSION BOX AND METAL FLUME 13,000 FT. LONG

manager's salary from $5,000 to $2,500 per annum. Fortunately he was defeated, and the chances are that the city-manager form of government will triumph and be firmly established beyond the reach of irresponsible politicians before another election for a commission majority occurs.

There are those in Phœnix who claim that its experience with city-manager government has demonstrated its failure—that the office has become a plaything in politics and the manager forced to become a politician—but that has not yet been proved.—N. C. R.

Long Straight Steel Flume

What is claimed to be the largest section of straight metal flume in the world is shown by Fig. 1. The length of the flume on tangent from the diversion box in the foreground to the distant mountains is 13,000 ft., or 2¼ mi. This structure was recently completed by the Colorado Culvert and Flume Co., Pueblo, Colo., for a private irrigation company in the San Luis Valley, Colorado.

The entire flume, including the portion beyond the diversion box, is 3⅛ mi. long and has in that distance a total fall of 750 ft.; the maximum grade is 7½%. The flume carries 70 sec.-ft. of water, and the velocity runs as high as 30 ft. per sec. As the flume passes through a sheep-grazing country, it is fenced the entire distance.

The three-way diversion box is also a somewhat unusual structure in flume work. It is constructed of reinforced concrete with 6-in. walls. This box and the other irrigation structures were built without engineering service, except that donated by the flume company.

The flume is of a patented type known as the "No-Lap" joint flume. A sketch of this joint is shown in Fig. 2. Each end of a flume plate has a semicylindrical head into which one of the double ribs or convex heads of an inside clamp or semicircular hoop fits. A similar clamp or half-hoop with concave cross-section fits over the ends of the flume plates; the carrier rod, tightened

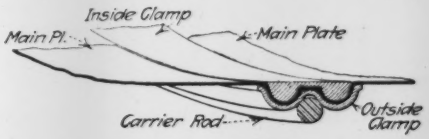

FIG. 2. DETAIL OF JOINTS IN FLUME

by nuts on the carrier beams or crossties, binds the whole together. The joints are spaced 35½ in. c. to c.

The flume illustrated is 3 ft. 10 in. in diameter and weighs complete about 16 lb. per lin.ft. The same type of flume is made in sizes up to 13½ ft. in diameter.

The foregoing information was obtained from L. R. Shallenberger, Manager of the Colorado Culvert and Flume Co.

Paving in Texas Is Hampered by the state homestead law, which prohibits a lien on property owned as a homestead for any debt whatsoever. A paving contractor in this state has to make individual contracts with each property owner whose property is affected by the laying of the pavement, for which the city authorities have awarded him the contract. He also has to carefully examine the title to every piece of property in order to give due consideration to the homestead law; he has to maintain a collection agency for the collection of the partial payments (often spread out over ten to twenty years) and has further to carry an organization of highly qualified officials and lawyers. All this adds from 10 to 20c. per square yard to the cost of the pavement. Naturally small contractors are unable to enter into competition with the large, well-organized and financially strong paving companies of national scope. Owing, however, to the many legal complications, it is doubtful, even with an absence of all real competition, if these paving companies succeed in making extraordinary profits. If the local representatives of some of these large paving companies express their true opinion of the situation they would much prefer to do business as in other states, where there are no such legal handicaps for the small contractor.

Lining Hill View Reservoir with Concrete and Riprap

By Arthur W. Tidd*

SYNOPSIS—Methods used in lining equalizing reservoir for new Catskill water-supply of New York City. Lining consists of lower level concrete paving and upper level stone paving and riprap. Methods of placing earth embankment described in "Engineering News," Sept. 9, 1915, p. 500.

Hill View Reservoir, on the line of the aqueduct for the new Catskill water-supply for New York City, is situated just north of the northern limit of the City of New York. It is an equalizing reservoir, its 900,000,000 gal. of water acting to modify the effect of the hourly fluctuation in the rate of draft, and correspondingly of inflow, and to maintain a nearly uniform head on the distribution system throughout the city. The reservoir is of the earth-embankment type, roughly rectangular, about 3,000 ft. long and 1,500 ft. wide; depth of water 36½ ft., capacity about 900,000,000 gal., area of water surface about 90 acres. The entire dependence for water-tightness is placed on the earth embankment, no core wall or cutoff wall being provided. The bottom of the reservoir and the lower half of the inside slope are faced with concrete, for purposes of cleanliness and with no intention of providing additional water-tightness. The upper half of the slope is faced with dry rubble paving and riprap. The formation at the site of the reservoir is a very hard-packed, dense glacial drift without stratification. No ledge rock was encountered. The material was well graded from coarse sand to rock flour and when in its original position, was impervious to water.

Placing Toe Wall and Berm Wall

The first work to be done on the concrete portion of the lining was the construction of the toe wall and berm wall. The toe wall is at the reservoir floor level and takes the thrust of the concrete slope lining. The berm wall is at the level of the berm and takes the thrust of the slope paving and riprap. The toe wall is about 7,400 ft. long and the berm wall about 7,700 ft. The first season both walls were built in alternate sections 16 ft. long with expansion joints every 48 ft. The expansion joints were formed by three ⅛-in. steel plates, three being used together, each thoroughly greased. By pulling out the center plate first, the other two were readily withdrawn. During the following winter it was found that the expansion joints in the berm wall allowed surface water to work through below grade instead of staying on the surface. The conditions were studied, and the design was modified to the extent of eliminating the expansion joints for the remainder of the work and also excavating for and casting a small cutoff block monolithic with the concrete on the berm at each expansion joint built the first season, whenever it was reached. Also, the construction method was changed by first excavating for and casting blocks 2 ft. long and of full section, 24 ft. apart on centers. The intermediate spaces were excavated and concreted after the blocks had set. This method was followed throughout the remainder of the work.

Preparation of Slope for Concrete Lining

The reservoir embankment was built up in 4-in. layers, each layer thoroughly rolled with 10-ton steam rollers. The embankment was built somewhat full on the slope and berm, so that when properly trimmed for placing the lining, material thoroughly compacted by the roller would be exposed. The slope for the concrete lining was uniformly 1 on 2; the berm was horizontal. The trimming was done with hand tools using mattocks for finishing, the material being cast to the foot of the slope for removal. Hubs 2 in. square were driven to finish line and grade (for trimming) at the edge of the berm and at the toe wall on lines 8 ft. apart and at right angles to the slope. The previously constructed berm wall provided the other necessary grade point on the berm. Intermediate points were set by string as needed. A low earth dam or a row of sandbags laid along the berm wall was often used to divert surface water from the slope above from the finished slope below, but some erosion was caused by the rain that landed beyond the berm, especially if the storm was of long duration. Wherever large gullies were formed by a concentrated flow, the contractor was given the option of filling them with concrete at the time of placing the lining or tamping them full of selected earth; both methods were used. The contractor trimmed as little area ahead of the concreting as possible in order to reduce the possibilities and amount of all erosion, as under the contract he was responsible for the extra quantities involved.

Placing the Concrete Slope Lining

The concrete slope lining was placed in alternate strips, 8 ft. wide, continuous from toe wall to berm wall, 3 or 4 strips usually being carried up at the same time (Fig. 3). Spruce timbers 4x9 in. were used for forms, spliced where necessary to make the form continuous up the slope, about 48 ft. When a form was moved, a gang of men lifted it bodily, walked up the slope far enough to clear the fresh concrete, then along the bank and finally down the slope again to the new position. The forms were set on the hubs used for trimming. The concrete was a 1:8 mix, using the regular 2-in. stone furnished for all concrete. It was delivered in bottom dumping buckets of 1⅓ cu.yd. capacity and handled into place by an electrically operated stiff-leg derrick traveling on tracks laid on the bottom of the reservoir along the foot of the slope (Fig. 2). For the first half of the work, the concrete was mixed in a 1½-cu.yd. Chicago cube mixer, but later by the 1½-cu.yd. Hains gravity mixer used for the bulk of the concrete work on the contract. It was essential that the quantity of water be carefully controlled, because if the batches were too wet, the whole mass would work down the slope, and if too dry, a great amount of tamping was required and the

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surface finish was unsatisfactory. The concrete was deposited directly on the prepared earth slope. Square-pointed shovels with extra long D-handles were used to spread the concrete and to finish the surface. No screeding was done, but the final shape was tested frequently with a wooden templet. No trouble was experienced in forming the raised portion along the joints. The concrete was sprinkled with a hose for about two weeks after laying. When the intermediate slabs were being laid, a flat ladder made of 7/8-in. boards placed on the previously finished concrete was of value in providing a secure foothold for the workmen and protecting the concrete. Seven drainage holes along each joint were formed by round wooden pins tapering from 2½ in. to 1½ in. in the thickness of the slab. They were designed to relieve the hydrostatic pressure that might be developed when the extreme south end. The thickness of the lining was uniformly 6 in. Excavating was done by steam shovel to within a reasonable distance of the concrete subgrade, the remaining material being removed by lighter tools and more easily controlled methods. Any steam-shovel excavation below grade was ordered filled with concrete at the contractor's expense. No refilling with earth was permitted, and all depressions were filled with concrete as the lining progressed in order to insure a suitable foundation for piers in case the reservoir should subsequently be covered. After the steam-shovel cut was made, a heavy spike-tooth harrow drawn by horses and supplemented by men with picks was used to loosen the earth. A four-horse road scraper scraped the loosened material into windrows, making the area quickly available for the harrow again. The windrows were taken up by wheeled

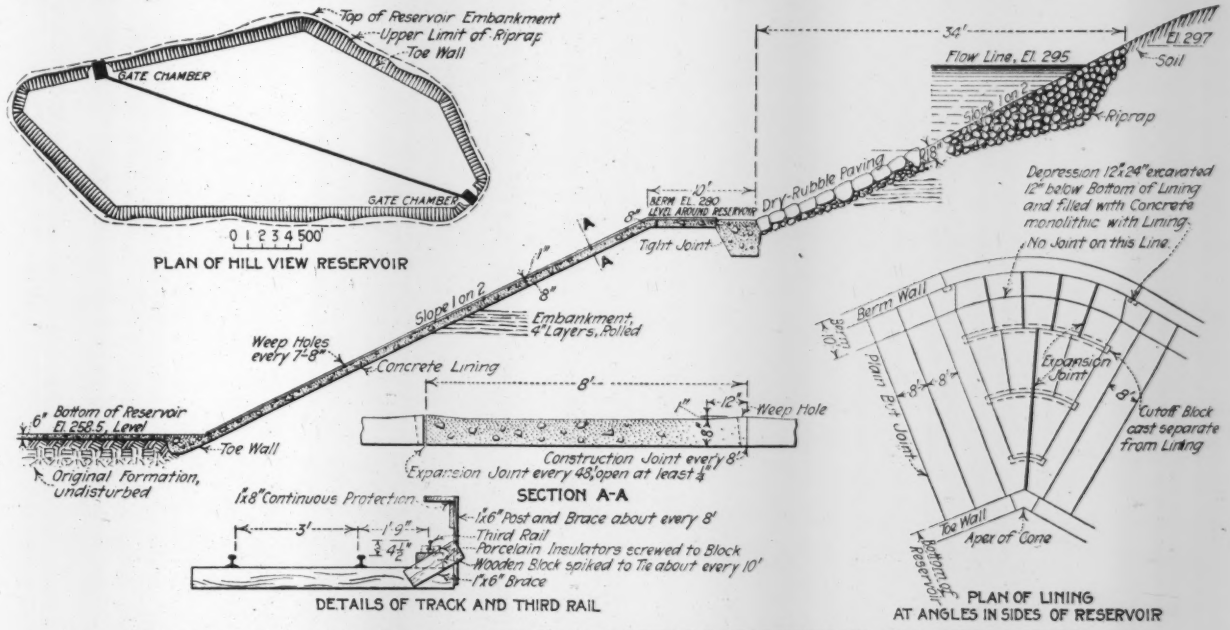


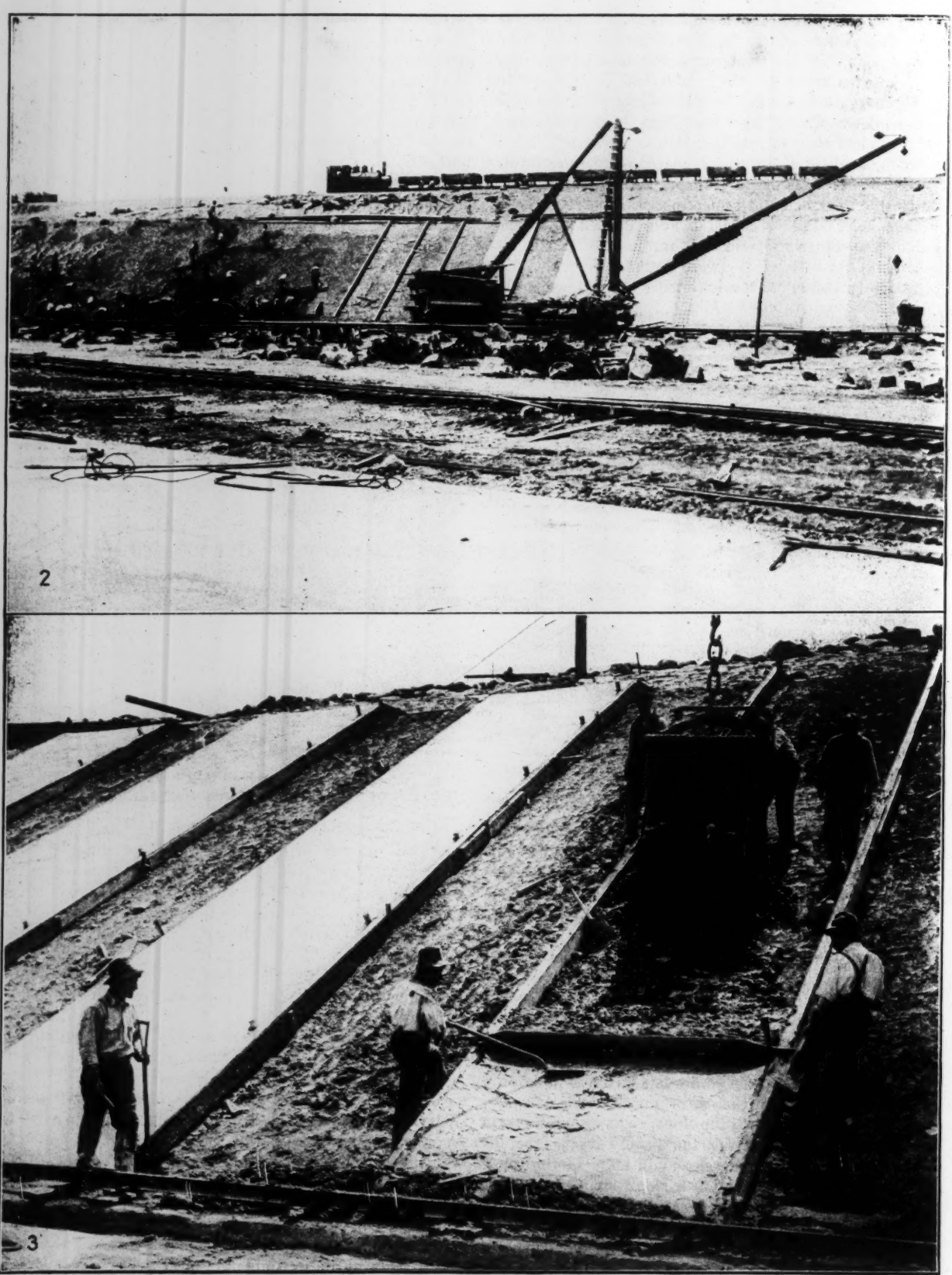
FIG. 1. PLAN OF HILL VIEW RESERVOIR AND DETAILS OF CONCRETE AND RIPRAP LINING

reservoir was lowered. The raised portion along each joint was to prevent surface water flowing down the slope from entering the joint and scouring out the subgrade. Every sixth joint (48 ft.) was an expansion joint about ¼ in. wide made by placing a strip of corrugated paper in the joint and concreting against it. The paper was left in place. All other joints were plain, untreated butt joints.

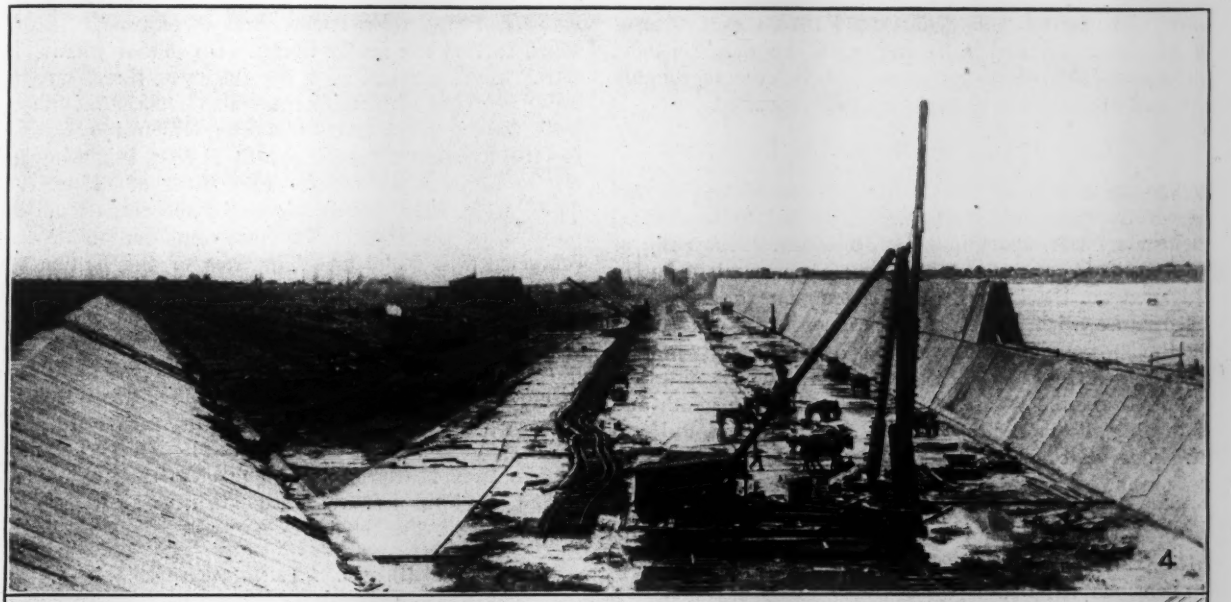
At the angles in the sides of the reservoir, a true cone-shaped transition was made (Fig. 1). A study of the formwork indicated that the best results would be obtained if joints were allowed along the slope as well as up and down it. Such joints had given trouble on a trial section early in the work on account of water entering as it flowed down the slope, scouring underneath the concrete and upheaving the lining at the foot by the hydrostatic pressure developed in spite of the weep-holes. To prevent this action a small strip of concrete was laid first in the subgrade at the horizontal joints. The device worked entirely satisfactorily. The raised joints were used on all joints running up and down the slope.

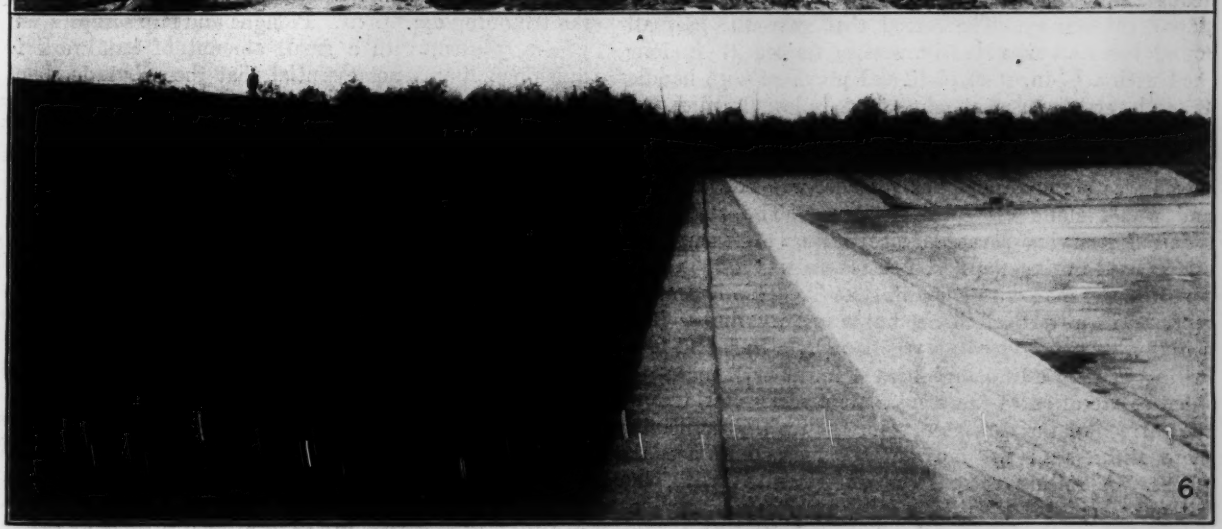
The entire bottom of the reservoir was level, the only provision for draining being at the gate chamber at the scrapers drawn by two horses and deposited either in the path of a near-by steam shovel or dumped in a spoil pile in case the shovel was at a distance. The finishing was done by men with mattocks or broad-edged picks trimming very closely to the prescribed lines. Hubs 2x2 in. were driven flush with the finished trimmed surface on lines 25 ft. apart each way, the hubs being later used for setting the forms for the concrete and for marking the joints. Boulders encountered in the bottom were allowed to remain if well below the finished surface of the concrete lining; otherwise they were blown out, all loosened material removed and the hole filled with concrete when the lining was placed.

The water impounded by rains often caused serious delays. After a short rain the mud was removed by scrapers or shovels ahead of the concreting gang without causing much interference. When much water fell, all operations were suspended. The water drained off slowly even when assisted by men with brooms and shovels to induce a current. Low earth dams were sometimes laid on the concrete lining already built to prevent that area from draining indiscriminately onto the graded portions. Various expedients were used, but usually progress was seriously impeded. In a few cases strips of lining 3 ft.



FIGS. 2 AND 3. PLACING THE CONCRETE LINING ON THE HILL VIEW RESERVOIR, NEW YORK CITY





FIGS. 4 TO 6. THE HILL VIEW RESERVOIR DURING AND AFTER LINING

Fig. 4—Looking over the reservoir while floor was being placed; dividing wall and conduit at right. Fig. 5—Screeding one of the floor panels. Fig. 6—Completed reservoir slope, showing concrete below, paved stone next above and riprap at top

wide were left open to assist in leading the water away, but their use was not general and in a very few cases ditches were allowed to be dug below subgrade for short distances. All such drainage channels were thoroughly cleaned to the natural material and concreted.

Placing Lining on Bottom of Reservoir

In the design of the lining on the bottom of the reservoir, expansion joints were specified to be formed not over 50 ft. apart in both directions. A spacing of exactly 50 ft. was adopted. The bottom was laid out in advance on that plan, and construction progressed in accordance with it. After experimenting with various methods, the contractor settled down on a policy of adjacent strips 25 ft. wide and as long as possible, 25 ft. being the practical limit for screeding width and screeding the most practical way for insuring a uniform thickness of concrete. A trial was made of the shovel-finish method used on the slope, but no feasible way was devised for keeping the thickness constant. Strips 12½ ft. wide were no easier to place than 25 ft., and alternate blocks 12½x12½ ft. and multiples of those dimensions entailed a considerable expense for setting and removing forms. The continuous 25-ft. strip proved to be well adapted and was used throughout practically the entire area (Fig. 4). Removable steel plates formed the expansion joints transverse to the direction of the strip, and corrugated paper laid against the concrete formed those in the longitudinal direction. The corrugated paper was left in place. The steel plate was well greased and a strip of building paper placed each side to facilitate withdrawal. The plate was kept in alignment by steel pins driven on each side. Timbers 4x6 in. were used for the forms along the outside edge of the strip of lining.

Concrete was handled into place in 1⅓-cu.yd. bottom-dumping buckets by a 15-ton Brownhoist steam-operated locomotive crane with a 52-ft. boom, running on track laid alongside, preferably, from the contractor's standpoint, on the concrete lining already built in order to give an unobstructed field for the trimming operations (Fig. 5). The concrete was sprinkled with a hose for about two weeks. The mix was 1:8 and of a rather sloppy consistency. The screed that gave the best all-round results was a 4x6-in. spruce timber 27 ft. long, shod with a ¼-in. steel plate and provided with handles at each end somewhat similar to plow handles. A camber of about ½ in. compensated for the sag, and it was found that the sag did not tend to increase. The screed was simply and quickly made, was not expensive and would stand all sorts of abuse. The steel strip required renewing perhaps twice during a season. The screed used during the first full season was a 2½x12-in. pine timber, shod with a $\frac{5}{16}$-in. steel T. This had ample stiffness in a vertical plane, but was very limber horizontally. As the screeding was done by a back-and-forth sawing motion, advancing about 4 in. at each move, the sidewise vibration of the screed left a series of ridges on the surface of the concrete. The 4x6-in. timber, having more stiffness in the horizontal plane, eliminated the ridges. A rolling screed was experimented with, but without success.

The concrete for most of the slope and all of the bottom was mixed in a 1½-cu.yd. Hains gravity mixer and transported to the work in bottom-dumping buckets on trailers hauled by third-rail electric motor cars running on 3-ft. gage track. The usual train consisted of one motor car carrying a bucket, and three trailers, two of which carried one bucket apiece. On the long hauls two trains were used and in a few instances three, turnouts being provided at suitable intervals. On the bottom the track for the motor trains was often laid inside the track for the locomotive crane, gage 4 ft. 8½ in., using one rail in common (Fig. 4). Two strips of lining, each 25 ft. wide, were usually placed by the crane from one position of the track. The maximum length of strip concreted was 2,300 ft. The area of the bottom was about 69 acres. The locomotive crane was used for moving both sets of track in all routine pregressive movements. The third-rail equipment was very elastic, gave excellent service, and only a few accidents, and those of no significance, occurred. The voltage was 550. The running rails were 40-lb. and the third rail 16-lb. The third rail was protected by a continuous covering made by two 8-in. boards at right angles to each other, supported by a light post and brace nailed to a tie about every 8 ft. (see Fig. 1).

Dry Rubble Paving and Riprap

From the berm, El. 280 to El. 287, the slope was faced with rubble paving laid dry, bedded in crushed stone. The paving stones were worked out of trap boulders, a plentiful supply being available from the excavation for the reservoir. The crushed stone was from the stock used for concrete. The slope of the embankment above the berm varied continually, no two adjacent sections being on the same slope. This was done to produce a sinuous shore line at all stages of the reservoir throughout the range of the daily fluctuations. The slope and cross-section of the paving and riprap were established in the office for every 25-ft. station around the reservoir (about 8,000 ft.) and sheets prepared for the use of the grade parties in the field. The non-uniformity of slope made it difficult to build up the embankment to the proper lines (embankment material was brought on in 4-yd. cars in 10-car trains), and in spite of stakes that were set for guidance at frequent intervals, considerable material required removal during the trimming operations. Ploughs and slip scrapers were generally used, with a small amount of handwork for finishing; it was not essential that the subgrade should be as accurately trimmed as for the concrete lining. The material was moved up the slope for removal. The stone was hauled in by wagons and dumped or rolled down the slope to the work. It was set to strings by men using bars. The slope of the top of the paving varied from 1 on 1.7 to 1 on 4.6, the thickness at El. 287 measured at right angles to the slope varying from 24 in. for the steepest slope to 18 in. for the flattest, the thickness at the berm wall being uniformly 18 in. About 250 ft. of slope was 1 on 2 or steeper, and about 150 ft. was 1 on 3.3 or flatter. For the remaining distance around the reservoir the slope lay between those two limits and about uniformly distributed.

Between El. 287 and El. 297 the slope was faced with riprap, El. 297 being 2 ft. above full reservoir level (Fig. 6). Above El. 297, the slope was finished with soil and grassed. The riprap varied continually in cross-section and slope, as did the rubble paving, but the finished surfaces were substantially in alignment at each 25-ft. station. Where the riprap joined the paving, the thick-

ness was identical for the flattest slope and 6 in. less on the steepest. At El. 297, the thickness was uniformly 2 ft. and vertical. The intermediate thickness, measured vertically, varied from 5.7 ft. for the steepest slope to 3.3 ft. for the flattest. The trimming methods were similar to those used for the slope paving. The riprap was dumped, cast or rolled into place, depending on the size of the stones and the condition of the slope. Sound and durable boulders of all sizes from the reservoir excavation were used. No handwork was required or used except in the final lining up of the surface.

Expansion Cracks and Frost Action in Lining

The provision for expansion and contraction in the concrete lining proved to be entirely satisfactory. One block on the bottom laid as a monolith 50 ft. square developed only one crack, and that diagonally across a corner, indicating frost action rather than contraction. The effect of frost was quite noticeable in the case of the small experimental sections on the bottom and was probably more or less general over the entire area, the concrete settling down again in the spring. Heaving was general on the berm and practically general on the slope, a crack usually showing on the slope not far below the berm. Only one crack, however, developed in the length of the strip. This lining did not tend to settle back into place, probably from the fact that surface water penetrating below it carried sediment or transported some of the underlying material. The weep-holes usually performed their function, but hydrostatic pressure was produced in two or three localities. In some cases water issuing from the weep-holes carried earth with it, but no settlement of the slabs was noticed. No trouble was experienced at the corners. No movement of any kind was ever detected in the berm wall or toe wall. None of the lining was seriously displaced in spite of the fact that some was exposed for two winters. Wherever possible, the concrete was protected during construction by flooding during the winter. After the reservoir has been put into service, the lining will be submerged, and no further disturbance is to be expected.

Behavior of Slope Paving and Riprap

The reservoir was filled for the first time in December, 1915, and has not been drawn down since, so that a complete inspection of the slope paving and riprap has not been possible. At a few disconnected places, the soil has worked into the upper edge of the riprap, and over a stretch of several hundred feet a general erosion of soil by waves took place during a very heavy northwest gale. The wave action was effective for about 5 ft. above the water level at the points of steepest riprap slope, about 1 on 2. As the slope flattened, the erosion diminished, the waves expending their force before reaching the soil. Some settlement of the riprap is visible at intervals, but it is not general in extent or serious in amount. On account of the short time that this portion of the slope protection has been subjected to service conditions, no general conclusions can be drawn. The reservoir is regarded as highly satisfactory.

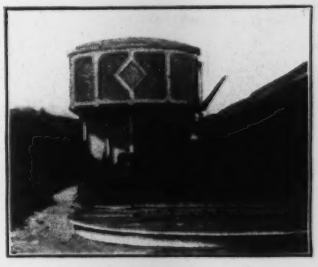
J. Waldo Smith is Chief Engineer of the Board of Water Supply, with Department Engineer Frank E. Winsor and Division Engineer Charles E. Wells in charge in the field during construction. The contractor was the Keystone State Construction Co., of Philadelphia.

Concrete Railway Water Tanks Eleven Years Old

The ornamental reinforced-concrete tank shown in the accompanying view is one of two tanks which were built in 1905 and are thought to be the first tanks of this type adopted for railway water stations. They are still in use and have proved entirely satisfactory. Each is of 60,000 gal. capacity and has the floor about 14 ft. above the rails.

These tanks are at Notasulga, Ala., on the Western Railway of Alabama, and at Hogansville, Ga., on the Atlanta & West Point R.R. Their cost was lower than that for steel tanks of the same capacity. They were designed and built by the Southern Ferro-Concrete Co., of Atlanta, Ga. Information has been given by O. T. Nelson, Superintendent of Maintenance-of-Way of the railways mentioned.

The tank is circular, 29 ft. 8 in. in outside diameter and 12 ft. 6 in. high. It is carried by girders on a circular row of outside columns 12x12 in. and a single central column 14x14 in. The wall is 4 in. thick, reinforced with rings of $\frac{3}{8}$- to $\frac{9}{16}$-in. rods spaced 5 to 8 in. c. to c. and with vertical $\frac{5}{16}$-in. rods. These latter are spaced 12 in. c. to c. and hooked over the top and bottom rings. The 4-in. floor is reinforced in both directions. Between the columns it has $\frac{5}{16}$-in. rods 12 in. c. to c.; outside of the columns it has $\frac{3}{8}$-in. rods 6 in. c. to c., alternate rods being bent up 18 in. into the side wall. The dome roof is 30 ft. 4 in. in diameter, with a rise of $2\frac{1}{2}$ ft., and has a 36-in. manhole at the center. This concrete is 2 in. thick reinforced with $\frac{3}{16}$- and $\frac{5}{16}$-in. rings, 12 in. apart, and with $\frac{1}{4}$- and $\frac{5}{16}$-in. radial rods. The latter have their ends hooked to a $1\frac{1}{2}$-in. rod in the coping.



RAILWAY WATER TANK OF REINFORCED CONCRETE
(Built in 1905)

The concrete was made with pit-run gravel from the railway company's pit at Chehaw, Ala. It was thoroughly mixed, of fairly wet consistency and laid as nearly continuously as possible. The mix was 1:2:4 for the tank and 1:2:5 for the other parts. As soon as the forms were removed, the floor and wall were given three $\frac{1}{4}$-in. coats of 1:1 cement mortar. After the tanks were filled, moisture appeared on the surface, but not to such an extent as to drip. This disappeared after a few weeks, and the tanks have since held their full amount of water.

A 4-in. curtain wall is built between the columns to form a storage room or toolhouse. The paneling of the tank adds to the pleasing effect of the design, and the diamond-shaped panel on the face (lettered "The West Point Route") is the railway company's trade-mark.

A Monorail Carrier for Lumber, with a length of about 25,000 ft., is to be installed at the lumber mill and yards of the Letcher & Moore Lumber Co., Galveston, Tex. The line will have 30 switches and about 45 curves of 30-ft. radius. It will be operated by three carriers or trolley hoists, traveling at 600 ft. per min. when light or 500 ft. per min. with load. Each carrier will have a 20-hp. motor for the hoist and a 15-hp. motor for traveling. They will handle 5-ton loads of lumber, in lengths up to 24 ft. This monorail system will be built by Pawling & Harnischfeger, Milwaukee, Wis.

Traveling Sewage-Distributor Changes, Springfield, Mo.

By Alexander Potter*

Concerning the design and construction of sewage-disposal plants, especially the novel features incorporated therein, much has been written in the past, but comparatively little is published concerning their operation under working conditions. Two years experience at Springfield, Mo., with power-driven sewage distributors installed principally because of the low head available—12 in.—is, therefore, of value. (For description of the Springfield sewage works see *Engineering News*, Dec. 4, 1913.)

The sewage distributors referred to in this article were manufactured at Birmingham, England, by Ham-Baker & Co., Ltd., and placed in operation in the fall of 1913. The type used is illustrated in Fig. 1, except that the motor and gear shown upon the carriage (which will be referred to later on) replace the original "gear" for releasing the right-hand clutch from the cable at the end of the run and engaging the left-hand clutch on the return drive. Distribution is accomplished by means of two steel feed tubes, each 7 in. in diameter, supported at each end and at the center by a cast-iron carriage braced together by rolled steel beams so as to form a rigid structure. Located in each feed tube in a line just above the horizontal diameter are 5/8x4-in. orifices, 15 in. c. to c. Lateral distribution can be further controlled by a distributing tube, 2½ in. in diameter, located just below the center of the two feed tubes. This distributing tube is built in 6-ft. lengths and can be raised and lowered to secure uniform transverse distribution onto the bed.

When the distributors were tested it was found that the 5/8x4-in. orifices were entirely too large for their purpose. Instead of acting as orifices, as intended, they acted under normal operating conditions as weirs, those located nearest to the siphon discharging so much of the sewage that the tube regulators could not be adjusted to give a satisfactory transverse distribution. Before the plant was placed in operation, this defect was remedied and a uniform distribution was secured by providing the orifices with adjustable slides and by shortening the length of those orifices which were discharging the sewage at too high a rate. Fig. 2 shows the siphon end of one of the distributors, the distributing trough, and, in the background, a distributor in operation. This distributor is operating under a head of 9 in., measured from the water level in the distributing trough to the top of the finished grade of the filter bed.

In designing and constructing the plant, the writer made provision so that in case it should be found impracticable to operate the distributors during zero weather their use could be temporarily discontinued and the filters used as contact beds. Although the winters at Springfield are severe, it has never been found necessary, because of freezing weather, even temporarily to abandon the use of mechanical distribution. With temperatures below 0° F., ice has never collected in the distributing troughs of the filters or in the distributors themselves in sufficient quantities to interfere with the operation of the distributors, neither has there been any interference with the operation of the distributors from ice collecting on the filter beds. However, during times of freezing rains it was found that the ice collecting on the driving cables tended to clog the reversing clutches and stall the machinery, requiring the constant attention of the operator to keep the plant running.

FIG. 1. TRAVELING SEWAGE DISTRIBUTOR FOR SPRINKLING FILTERS, SPRINGFIELD, MO.

Although the experience at Springfield shows that mechanical sewage distributors can be operated successfully in all kinds of weather by means of the cable drive generally used with this type of machine, the writer does not recommend at this time the use of cables because of their high cost of maintenance and operation. At Springfield it was found that the cables had to be replaced every six months, deterioration being due to wear and tear accentuated by corrosion, the cables being more or less exposed to the spray. In addition to the rapid deterioration of the cables, the guide pulleys, rollers, etc., were found to wear out rapidly, and needed frequent replacing.

The experience at Springfield with cable-driven Ham-Baker traveling sprinklers is similar to that at Glasgow, Scotland, where in June, 1913, four distributors of the same type were installed at the Dalmarnock Works. It is reported that the rope drive for these distributors was found to be unsatisfactory, the cables, ball bearings, sheaves and pulleys wearing out rapidly and giving no end of trouble.

The average yearly cost of operating the six traveling distributors at Springfield was about $350 per year for

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the maintenance and renewal of cables, pulleys, rollers, chains and clutches, and $480 for gasoline and cylinder oil, the six machines being driven by a 6-hp. Otto gasoline engine.

In so far as the city was concerned, the attitude of the administration seems to have been that the city had fulfilled all the obligations required by law when it had constructed the sewage disposal plant and that there was no serious obligation resting upon the city for the proper and effective maintenance of the plant. As a result, some of the distributors could not be operated at times, due to lack of spare cables or other essential parts. Fortunately, the city had placed in charge of the plant J. E. Guinn, a resourceful man of considerable mechanical ability. When in the fall of 1914 one of the distributors was out of order, due to a worn-out cable, no spare cable being at hand, he substituted, largely at his own expense, for the cable drive a direct motor drive for this distributor, as shown in Fig. 3.

The device is a very simple one. A ¼-hp. motor, mounted directly upon the frame of the distributor, operates the driving mechanism by means of a belt. The speed is reduced by a set of worm and bevel gearing to about 38 ft. per minute. Reversal of direction is secured by stops, securely fastened, one at each end of the track. This stop trips the lever handle *A*, Fig. 3, attached to a sliding collar *B*, which engages by means of a lug the proper bevel gear *C*.

At the end of its run the distributor is brought to rest by means of a spring buffer. The mechanism on being reversed by the stop can make a complete turn of the driving bevel gear before the gearing is positively engaged. This short period of rest is sufficient to permit the energy stored up in the compressed spring of the buffer to start the distributor on the return travel without undue shock to the driving mechanism.

After having thoroughly tried out the direct motor drive on one of the distributors and having found it to be a decided improvement over the cable drive, the writer recommended its installation on all of the six units, which has since been done.

The advantages of the direct drive as compared with the cable drive are:

1. Saving in power, the brake horsepower required to operate the six units being reduced from 3 to 1, as determined by actual test.

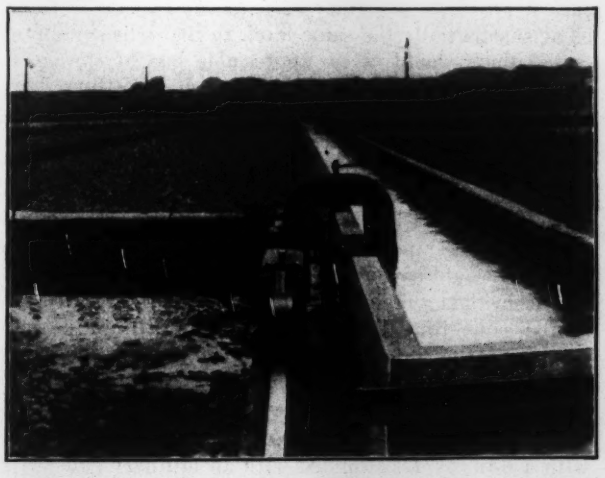


FIG. 2. SIPHON AND SEWAGE-DISTRIBUTING TROUGH

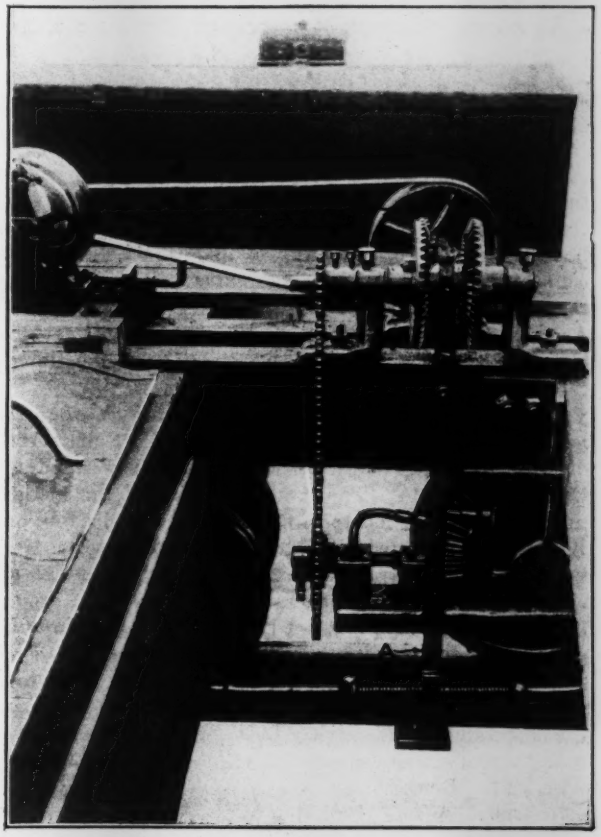


FIG. 3. DIRECT MOTOR DRIVE FOR SEWAGE DISTRIBUTOR

2. Saving in first cost. The cost of installing the direct drive is less than one-third of the cable drive.

3. Saving in moving weight. The motor-driven unit weighs 700 lb. less than the cable-driven unit.

4. Length of filter unit can be increased at will, thus reducing the number of travelers per unit of area. With the cable drive the economic length of a filter unit is limited to 200 ft. For lengths greater than this the cable becomes so heavy as to make it difficult to operate.

5. Saving in maintenance. The maintenance cost of the direct drive averages about one-sixth of the cable drive.

The accompanying table is a comparison of the cost of operating the mechanical sewage distributors at Springfield by the two methods. The figures given are exclusive of the cost of installation and fixed charges on the distributors proper, rails, etc., items common to both drives. Including all these items, amounting to $7,000, the total cost of distribution per million gallons becomes $1.25 for cable drive and $0.61 for direct motor drive.

COMPARATIVE COST OF CABLE-DRIVEN AND MOTOR-DRIVEN SEWAGE DISTRIBUTORS, SPRINGFIELD, MO.
Six units, each 53x200 ft.; speed of distributor, 36 ft. per min.

	Cable Drive	Direct Motor Drive
Prime mover	Two 6-hp. Otto gasoline engines	Six ¼-hp. motors
Average b.hp. developed	3	1
Cost of installation	$3,000	$900
Yearly cost of power	480	200
Yearly cost of maintenance	350	50
Total of fixed charges, maintenance and operation	1,010	304
Cost of distribution:		
Per acre per year	692	208
Per million gallons	0.92	0.28

Water Equalization Between Distant Standpipes

By Charles W. Sherman*

It sometimes happens that it is desirable to have two or more standpipes a considerable distance apart, to furnish storage in a water-works system. In such a case the loss of head while pumping is going on will seldom be the same to both standpipes, and if both are freely connected with the mains the water will not stand at the same elevation in both while they are being filled. As soon as pumping ceases, however, water will equalize between the two standpipes, and a portion of the storage capacity theoretically available will be lost.

Under certain conditions the capacity which would be lost in this way may be very considerable. Such a condition existed at Needham, Mass., where a new standpipe was built in 1915. The circumstances and the method proposed to overcome the difficulty are described below.

Fig. 1 shows in outline the main piping system between the pumping station and the standpipe in Needham, leaving out of consideration all pipes 6 in. or less in diameter and all pipes not lying between the pumping station and the standpipes. The works were built some 25 years ago, the water being pumped from wells to a standpipe on Ryan's Hill. This standpipe is 25 ft. in diameter and 85 ft. high. Last year, for the purpose of furnishing additional storage and better to protect a rapidly growing portion of the town, a tank 55 ft. in diameter and 44 ft. high was built on Bird's Hill. The main pump at the pumping station has a capacity of 1,500,000 gal. per day.

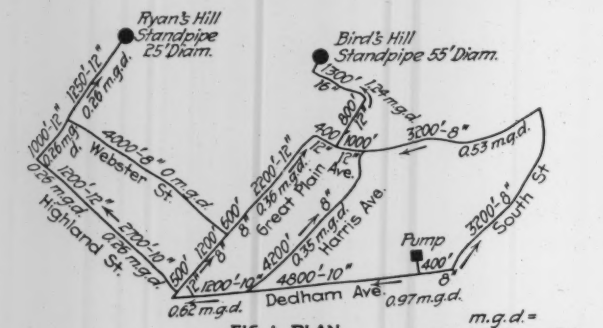


FIG. 1, PLAN

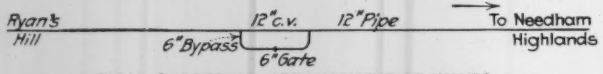


FIG. 2 SUGGESTED ARRANGEMENT OF VALVES

WATER EQUALIZATION BETWEEN STANDPIPES

With a complex network of pipes and with water abstracted from the pipes for consumption at various points all along their extent, it is obviously impossible to make precise computations. For the purposes of approximation all of the mains were assumed to be in substantially identical condition as regards age or roughness of interior surfaces, and the coefficient $c = 100$ in the Hazen and Williams formula was assumed. Computations were made by the Hazen and Williams slide-rule.

Assuming a condition when no water is being consumed from the pipes and all of the water pumped goes into storage in the standpipes, it is obvious that within a very few minutes after starting the pumps a condition of equilibrium will be attained, with a certain proportion of the water going to each of the standpipes and with a definite loss of head between the pumps and each tank. The loss of head from the pump to each tank will remain constant, and the hydraulic grade lines will simply rise parallel to themselves as the tanks fill; that is to say, the water level will rise at the same rate at both of the tanks. Under the existing circumstances, therefore, the standpipe on Bird's Hill being so much larger in diameter than that on Ryan's Hill, nearly five-sixths of the water pumped goes to Bird's Hill standpipe, or, with the pump running at a rate of 1,500,000 gal. per day, water will be going to Bird's Hill standpipe at the rate of 1,240,000 gal. per day and to Ryan's Hill at the rate of 260,000 gal. per day.

It had originally been assumed locally that, because the Bird's Hill standpipe is so much nearer the pumping station, the loss of head would be less and the Bird's Hill standpipe would be full before that on Ryan's Hill reached the overflow. A consideration of the relative quantities flowing to the two standpipes and the almost insignificant loss of head between the corner of Dedham Ave. and Great Plain Ave., and the Ryan's Hill standpipe showed on the contrary that there would be a considerably larger loss of head from the pumps to Bird's Hill than to Ryan's Hill. A series of approximate calculations indicated that the total loss of head from the pumps to Bird's Hill would be about 34 ft. and to Ryan's Hill about 27 ft., or that the standpipe on Ryan's Hill would overflow while that on Bird's Hill still lacked about 7 ft. of being full. Under such conditions, of course, pumping would be stopped and water would equalize between the two standpipes, with a drop of nearly 6 ft. at Ryan's Hill and a rise of but a little over 1 ft. in the Bird's Hill standpipe. The upper 6 ft. of the Bird's Hill standpipe would, under such circumstances, be substantially useless.

It is obvious that in order to have both standpipes fill simultaneously the total loss of head from the pumps to both of the standpipes must be the same. This result can be obtained by inserting resistance in the pipe line between the pumps and the Ryan's Hill standpipe, as for instance by partly closing a gate near the base of the standpipe. This could be done experimentally in such a way that the water level in the two tanks would be at substantially the same level, so that when pumping ceased there would be no appreciable loss of storage in either tank due to equalization. Such throttling, however, would render the water stored in the Ryan's Hill standpipe practically useless for fire purposes, since the loss of pressure in getting water out of the standpipe at high velocities, through a partly closed valve, would be considerable, and in case of a fire in that section of the town while the pumps were not running, the pressure available would be very largely reduced.

The method suggested to overcome this difficulty and at the same time to make possible throttling the gate leading to the standpipe so as to equalize the elevations during pumping is shown in Fig. 2. A 12-in. check valve opening outward is to be inserted in the pipe leading from the standpipe a short distance from its base, with a 6-in. bypass supplied with an ordinary gate valve. The 6-in. connection of itself would serve to reduce the

*Of Metcalf & Eddy, Consulting Engineers, Boston and Chicago.

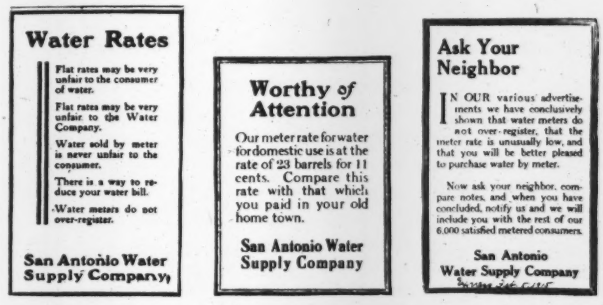
pressure somewhat, and by throttling the gate experimentally the proper degree of equalization can be obtained, while the 12-in. check valve opening outward would make available the full capacity of the standpipe at once in case of sudden fire draft.

Creating a Popular Demand for Water Meters

What may be accomplished in creating public sentiment in favor of adopting water meters and in promoting the business of a private water company is shown in the experience of the San Antonio (Tex.) Water-Supply Co., of which Robert J. Harding is vice-president and general manager.

The water-supply of the city comes from artesian wells at the main pumping station, which is in the heart of the city, and from artesian wells at a suburban pumping station. The water-bearing strata extend under practically the whole city, so that any private party may have a well boring 800 or 1,000 ft. In order to obtain the business of all the water consumers, the water-works plant must not only be economically operated, but the water company must have and keep a certain amount of popularity.

The rates for water service of various characters are fixed by a 10-yr. contract, made in 1914, between the


Water Rates
Flat rates may be very unfair to the consumer of water.
Flat rates may be very unfair to the Water Company.
Water sold by meter is never unfair to the consumer.
There is a way to reduce your water bill.
Water meters do not over-register.
San Antonio Water Supply Company
Worthy of Attention
Our meter rate for water for domestic use is at the rate of 23 barrels for 11 cents. Compare this rate with that which you paid in your old home town.
San Antonio Water Supply Company
Ask Your Neighbor
IN OUR various advertisements we have conclusively shown that water meters do not over-register, that the meter rate is unusually low, and that you will be better pleased to purchase water by meter.
Now ask your neighbor, compare notes, and when you have concluded, notify us and we will include you with the rest of our 6,000 satisfied metered consumers.
San Antonio Water Supply Company

FIGS. 1 TO 3. NEWSPAPER ADVERTISEMENTS WHICH CREATED A POPULAR DEMAND FOR METERS

city and the water company. The city in a large measure prescribes the rules and regulations governing the service of the company. The price fixed for a service connection is $15 for a ½-in. pipe and $20 for a ¾-in. pipe. The company installs lead service pipes inclosed in 4-in. tile, so that it loses money with practically every installation.

The contract with the city makes the installation of water meters optional with the consumer, or in the case of improper use or waste of water the company may insist on the installation of a meter. Notwithstanding the fact that the company buys and installs the meters, the old popular prejudice against the metering of anything as plentiful as water prevailed until Mr. Harding decided to convince the people of the real economy of water meters. To this end he inserted newspaper advertisements, of which Figs. 1, 2 and 3 are samples. By this means a popular demand for meter installations was created—a greater demand than the meter-purchasing budget of the company could meet.

Another use of advertising has been to promote the consumption of water. The pumping plants are of course most economically operated when they are running to capacity. Hence, to increase its revenues, the company has encouraged the legitimate consumption of water. This is purely a business consideration; but, as will readily be seen, it is founded on the principles of economical operation, which would apply with equal force to municipally owned water-works. The tendency too often is

GROWING
NOW is the time to arrange with Nature to do something for you. Roses are now will furnish cut flowers for the Spring Carnival. Fruit trees, shade trees, ornamental shrubs and evergreens should be planted. In fact, if you want to start something, just sprinkle your lawn with a liberal supply of water and watch the green grass appear.
If you are having water on a flat rate, get your money's worth. If you are on a meter, it's the cheapest thing you buy.
San Antonio Water Supply Company
Throw Away the Can Opener
You have the soil, the climate and the water, and with a very little energy your table can be supplied with fresh vegetables. A garden from which during every month of the year you may reap a reward for your efforts.
Don't let water at ten barrels for a nickel, delivered, stand in the way
San Antonio Water Supply Co.
New Service Pipes
When you need a lead service pipe in preparation for a new pavement or to renew your old galvanized one, remember this.
We recommend for an ordinary eight-room residence a half-inch pipe from the water main to the property line if you are on the near side of the water main. If on the far side, it should be a three-quarter.
Simply the changing of the pipe in the street will not correct the faults in the piping on your property. Regardless of the size of the lead service, make the pipe in your yard one unit.
San Antonio Water Supply Co.

FIGS. 4 TO 6. ADVERTISEMENTS TO PROMOTE WATER USE AND INDUCE NEW CONNECTIONS

to discourage consumption on general principles without consideration of the most economical capacity of the plant.

The normal climate of San Antonio is fairly dry, and to keep grass and flowers requires a little irrigation. To encourage the use of water for this purpose, advertisements like Figs. 4 and 5 have been found effective. Another use of the newspaper advertising columns has been to encourage the installation of new services before street-paving operations were begun (see Fig. 6). The profit in this was more the good will of the city authorities than increased consumption.

The result of this publicity work, together with a fair and open policy of administration of the water company, has had quite a remarkable effect on public sentiment generally. It has also had a rather odd psychological effect in convincing employees. Although well primed with arguments in favor of water meters, the employees are apparently themselves convinced by reading the advertisements and are ever afterward most earnest advocates of the company's policy.

Sewer Pipes from Hawaiian Molten Lava—The making of sewer pipes and bricks of the molten lava from the active volcano Kilauea is advanced as a business proposition by W. S. Townsend, a retired Ohio manufacturer of sewer pipes, who visited the Hawaiian Islands in February. The volcano is on the Island of Hawaii, 32 mi. from Hilo, and reached directly by automobile over a smooth road that dips down through a break in the wall of the old crater to the floor of dead lava and thence almost to the brink of the pit of Halemaumau (House of Everlasting Fire). Mr. Townsend declared that, with proper machinery, pipes could be molded from the lava in exactly the same manner as pipes are molded from molten material in foundries. He advanced a plan to erect endless bucket conveyors that would bear the lava out of the pit, the buckets to be made of a special material capable of withstanding heat up to 2,000° F. (The research work now being carried on under the direction of Prof. T. A. Jagger, of the Massachusetts Institute of Technology, has proved that the temperature of the molten lake is about 1,800° F.) Mr. Townsend expressed the belief that the lava would remain liquid during the short time it would be on the way to the molds, which could be placed in a building near the edge of the crater. For the past 10 yr. the Lava Brick Co., Honolulu, has been making building bricks from lava rocks. Its plant is located in the district of Kaimuki, where there is a vast outcropping of lava rocks from ancient volcanic flows. These bricks are gray in color and have been used extensively in the construction of buildings and particularly in sewer, manhole and fireplace work. Mr. Townsend's idea was considered quite unique in Honolulu when made public and has been taken seriously.—"Commerce Reports."

Spring Water for Fort Huachuca

By R. C. Hardman*

The growth and importance of a community in the arid Southwest are often contingent upon the extent of its water-supply; consequently, the smallest source of potable water is not neglected. Fort Huachuca, Ariz., a cavalry post near the Mexican border, was limited in this respect, the old water-supply derived from springs in the cañon above the post being barely adequate for the six troops of cavalry quartered there. During the border troubles of the past five years large increases have been made in the garrison, often more than double its normal allotment. The old water-supply, while sufficient during the winter and the rainy season in July and August, was so small at other times that the use of water had to be prohibited for several hours during the day, to allow water to accumulate in the reservoirs. To remedy this condition and to provide for any desired permanent increase in the garrison, three small springs furnishing the supply for what might be called an intermittent stream in Garden Cañon, about 9 mi. distant, were developed and the water carried to Fort Huachuca (see Fig. 1).

The flows from the springs were measured by means of rectangular weirs for a period of several months, the period commencing in early spring before the winter snows had disappeared and continuing through the extremely

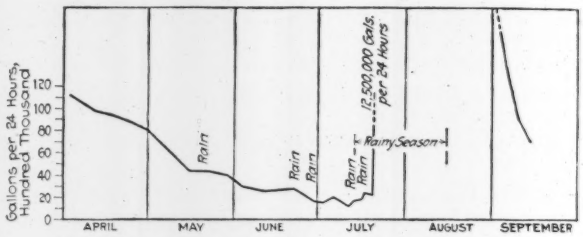


FIG. 2. FLOW OF SPRINGS, FORT HUACHUCA WATER-SUPPLY

dry early summer and the July and August rains. The discharges were computed by the Francis formula, the combined results obtained being shown in the accompanying diagram.

The springs were located in a limestone formation said to be very similar in appearance to the Mammoth Cave region. About a quarter of a mile above weirs 1 and 2 was a cave, unnoticeable in the dry season, which in the wet season poured forth a stream of water some 20 ft. wide and from 6 to 8 in. in depth, apparently from a subterranean lake. As will be seen from the diagram (Fig. 2), the entire flow of the stream at weirs 1 and 2 (weir 2 measured the flow from weir 3, together with about a mile of stream between 2 and 3) fell to 120,000 gal. per 24 hr. during the dry season. This flow (0.1856 sec.-ft.) was taken as the minimum. During this period of low flow, of the nine creek crossings made by the pipe line five were absolutely dry, the flow being carried by subterranean channels. The maximum flow observed was, as nearly as it could be gaged, about 12,500,000 gal. per 24 hr., or 19.33 sec.-ft. The method of collecting the flow from the springs and the creek above them is seen in Fig. 1.

The main springs burst forth from the side of a 45° slope and were surrounded by numerous seepages. A small concrete collecting gallery was provided to receive the entire flow by intercepting the normal flow to the creek. As will be seen, the collector was provided with an 8x12-in. opening on its upper side, in front of which were placed broken stones to prevent the entrance of foreign matter likely to obstruct the pipe. The natural formation of the site made it easy to collect the water from the creek itself. Immediately below weir 2 is a limestone ledge about 6 ft. in height, at the foot of which is a natural pool some 5 ft. in depth that receives the entire flow of the stream in times of normal flow. A 6-in. pipe connects this pool with the collector. In times of flood

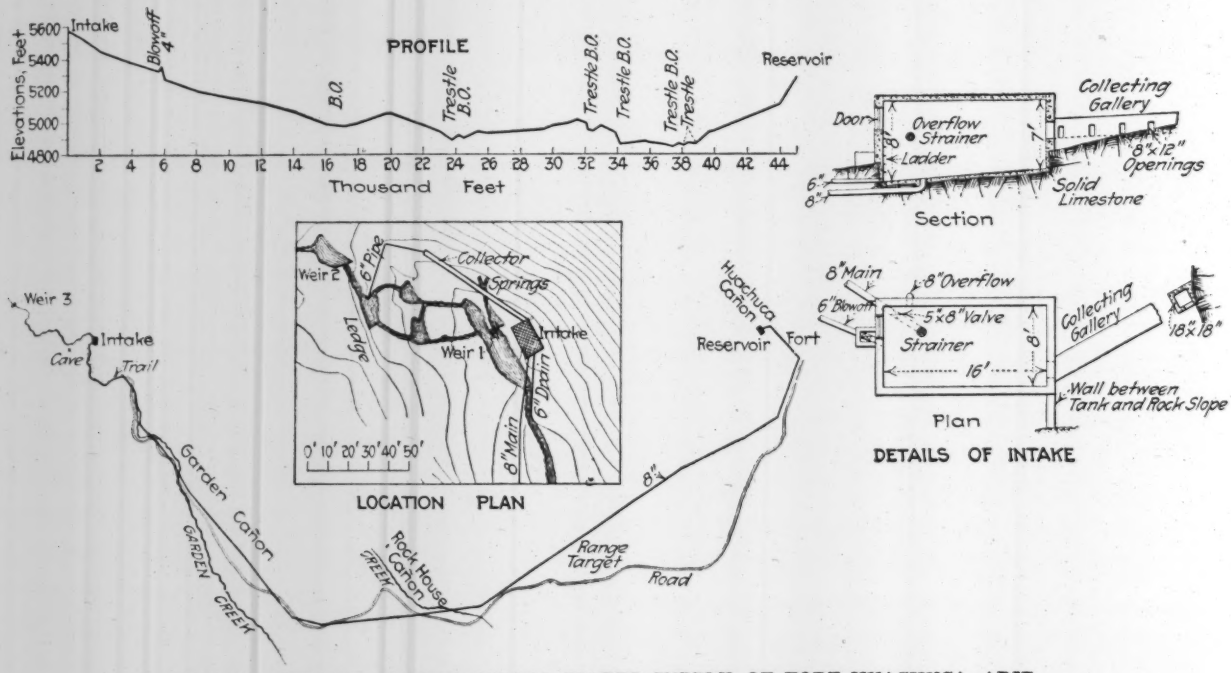


FIG. 1. DETAILS OF THE SPRING WATER-SUPPLY OF FORT HUACHUCA, ARIZ.

*Colorado Springs, Colo.

the stream cascades from the ledge to a point considerably below the intake chamber.

The intake presents no unusual features. The construction of the pipe line, which is of 8-in. steel pipe with Dayton couplings, was relatively easy. About 1½ mi. was through loose and solid rock, the remainder through a hard adobe soil thickly interspersed with granite boulders. The ground was so heavily strewn with boulders over most of the line that hauling was difficult. All material for the construction of the intake works and the last half mile of line had to be transported on burros, because of the extremely rugged nature of the cañon.

The line was carried over several arroyos on timber trestles; elsewhere 18 in. of cover was provided. At the reservoir end the pipe discharged into a reinforced-concrete tank 4 ft. in diameter, placed upon the dividing wall between the two concrete reservoirs. The water was delivered to either reservoir, as desired, by means of gates in the sides of the tank. No valves were placed at the reservoir end, so that the line cannot be subjected to a static head, which would place the low point of the line under a pressure of 312 lb.

Horizontal angles were made by long curves wherever possible, but in the upper part of the line the cañon was so restricted that cast-iron specials were used. The total curvature of the line is 1,070°, of which 763° is in the first 5,569 ft.

The labor on the work was entirely Mexican, at $1.75 per 8-hr. day. A gang of five men laid and jointed up as much as 3,000 ft. of pipe in one day, although this was far above the average and only possible on long tangents. Along the upper end 300 ft. per day was considered good.

The line was subjected to a test pressure of 250 lb. during construction, with the development of but one leak in the Dayton couplings, which was due to the absence of one bolt.

The work was designed by P. E. Borchers and built by Griffith & Pacheco, Tucson, Ariz., with R. C. Sparks as superintendent for the contractors and the writer as superintendent of construction for the War Department. The cost of the work was approximately $40,000.

Brick and Asphalt Paving by Day Labor

By G. C. Brehm*

In the past year 1,374 sq.yd. of brick and 16,728 sq.yd. of asphaltic-macadam paving have been constructed by day labor in Waynesboro, Penn., under the writer's supervision. In the case of the brick pavement the grading was very heavy and extremely hard on account of resurfacing the roadway with macadam for several years previous to the construction of the brick pavement. The average cut was 16 in. of solid macadam.

The base was 4 in. thick and consisted of a mixture of 1:2 ½:5 (limestone) mixed with a Colton continuous mixer. The sand cushion was 2 in. deep. Most of the sand was procured from the foundry of a local factory, the only cost being for the hauling. This bed was prepared with great care. After being drawn off with a templet it was rolled with a 500-lb. roller; all the depressions were then filled, the templet drawn over it and again it was rolled. This operation was repeated at least three times. When the brick had been placed and thoroughly rolled with a 6-ton roller, the surface was sprinkled and a 1:1 cement grout applied in the usual manner. Expansion joints 2 in. wide were placed along the curbs on both sides of the street.

Of the 16,094 sq.yd. of asphaltic-macadam pavement, 6,122 yd. was laid on Clayton Ave. on a crushed-stone base 2½ in. thick, after rolling. No grading was necessary on this street, but the fine stone used contained about 75% dust and had to be screened. Haulage was high, because the stone was loaded into wagons by hand shoveling. The binder was Aztec asphalt, which was applied by means of pouring cans.

The cost of this work was 41c. per sq.yd., divided as shown in the table.

COST DATA ON 6,122 SQ.YD. OF ASPHALTIC MACADAM PLACED BY DAY LABOR

Unit	Amount	Rate	Total Cost	Cents per Sq.Yd.	Total Cents per Sq.Yd.
3-in. and 2-in. stone	696.2 tons	$0.90	$643.30	10.51	
	20.9 tons	.80			
Hauling, 1 mi.	505	.50	252.50	4.12	
Spreading	295	.16	47.20	.77	
Rolling	74	.25	18.50	.30	
Coal	2,500 lb.	.002	5.00	.08	
Oil	1¼ gal.	.50	.75	.01	
Supervision			15.00	.25	16.03
Asphalt	13,507 gal.	.061	823.93	13.46	
Hauling	53	.50	35.78	.58	
	58	.16			
	108	.20			
Applying	342	.18	167.80	2.74	
	529	.16			
Wood	6 cords	6.00	36.00	.59	
Oil and waste	27½ gal.	.12	5.55	.09	
	15 lb.	.15			
Supervision			60.00	.90	18.36
1-in. and ¾-in. stone	99.2 tons	.90	89.28	1.46	
Hauling	83	.50	41.50	.68	
Spreading	1.39	.16	22.24	.36	
Rolling	20	.25	5.00	.08	
Coal	1,500 lb.	.002	3.00	.05	
Oil	3 qt.	.125	.37	.006	
Supervision			8.00	.13	2.76
¾-in. stone	49 tons	.90	44.10	.72	
Hauling	51	.50	25.50	.42	
Spreading	123	.16	19.68	.32	
Rolling	15	.25	3.75	.06	
Coal, oil and supervision	.....	.....	91.35	.15	1.67
Miscellaneous (clean-up)	.....	.....	121.00	1.98	1.98
Total	.....	.....	$2,540.08	.....	40.80

Another street, Church St. (North to Third St.), was paved with the same sort of material. Here, however, a small amount of grading was necessary. The total yardage was 4,243 and the cost was $1,745.79, divided as follows:

Grading	$120.65	$0.028
Bed stone (labor)	35.46	.008
2-in. stone (labor)	152.08	.035
¾-in. stone (labor)	32.35	.007
½-in. chips (labor)	45.04	.010
Hauling asphalt	44.74	.010
Pouring asphalt	91.12	.021
Miscellaneous	44.66	.010
Coal, wood, oil, etc.	44.89	.010
Stone	625.50	.147
Asphalt	509.30	.120
Total	$1,745.79	$0.406

On Cleveland Ave. 4 in. of crushed stone was placed on the rolled subgrade, covered with screenings and then thoroughly wet and rolled. A stone base 2 in. thick was then spread over this and the asphalt was applied. Just enough ¾-in. stone to take up the voids was then spread over the hot asphalt and the whole was again thoroughly rolled. After applying about ½ gal. of asphalt per sq.yd. the surface was covered with ½-in. chips and rolled. Bermudez asphalt was used on this street. The total cost of the work here was $515.05 for 634 sq.yd., or 80c. per yd.

On two other streets 5,729 sq.yd. was constructed at a cost of about 43c. per sq.yd. The old macadam street was used for the base, and on this 3 in. of stone was placed and then the asphalt, which was Aztec.

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Rogers Pass Soft-Ground Work

By J. G. Sullivan*

Tunneling by such a method as to make the larger part of the excavation yardage accessible for steam-shovel mucking is the feature of the Rogers Pass tunnel work on the Canadian Pacific. This method might not seem well adapted to soft-ground work, but it has been applied with full success in the two portal sections as well as in several soft-rock sections farther in.

At the east end there was 1,300 ft. of tunnel through more or less cemented mountain débris. The method followed here was first to drive two wall-plate drifts (see Fig. 1 herewith), then stope out between these two drifts at various points (Fig. 2) and place five-segment arch timbering (Fig. 3). The core of the cross-section and everything below the wall plate was excavated by steam shovel (Fig. 4), the shovel removing over 66% of the total excavation in this section.

Practically the same method was followed in several soft spots encountered in solid rock. The tunnel was stoped out to the level of the wall plate and the arch timbers placed.

Seven-Segment Method in Loose Wet Ground at West End

At the west end there was about 400 ft. of very heavy ground, consisting of much looser material than at the east end. It contained large boulders and carried considerable water. The method employed here differed from that used at the east end in some important particulars. A seven-segment arch was used, and it was carried directly on posts instead of on a wall plate. To set this timbering five drifts were used. There were two superimposed drifts on either side, clearing a way for the posts, and there was also a crown drift. As soon as the posts were set, the ground between the upper post drift and the crown drift was stoped out and the arch segments set.

This method, of course, was very expensive in the use of timber, but it permitted the steam shovel to excavate the entire core of the tunnel, at this point about 51% of the total excavation. Except for the desirability of getting the steam shovel into rock as quickly as possible, very much lighter timbering and bracing would have been used. The essential purpose of the whole method was to allow the steam shovel to go through and reach rock as quickly as possible.

One peculiarity about this section, which caused some concern, was the problem of how to support the roof load until a concrete base could be put in. The top load was so heavy that even 12x16-in. timbers set solid would not carry the burden without crushing. These timbers were doubled, two sets of posts as well as two sets of arch timbers being used.

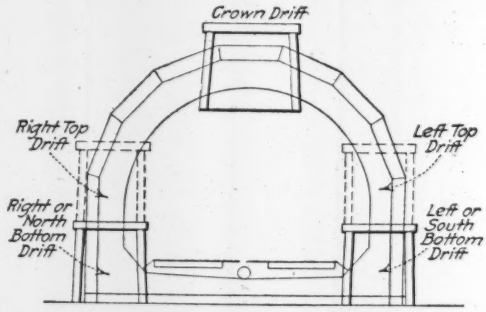

FIG. 6. SEVEN-SEGMENT TIMBERING IN WEST END; TIMBERS SET SOLID AND USUALLY DOUBLED

The posts rested on mud sills no wider than the post, and strange to say, no settlement took place, in spite of the fact that the ground was very soft when disturbed. The ground when worked up by the steam shovel would get so soft that the shovel would have buried itself if not carried on a solid floor of timbers. The explanation is, of course, that when the water was drained off the ground became very hard, and that the roof timbers acted as a perfect arch, carrying the load to the surrounding ground by arch action instead of transmitting it to the posts.

The original intention was to put in a solid floor of concrete, as shown in Fig. 6, but finally only a strut 18 in. wide every 30 ft. was used.

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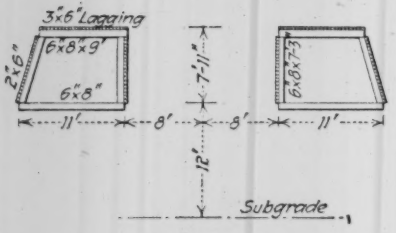

Fig. 1. Two Wall-Plate Drifts

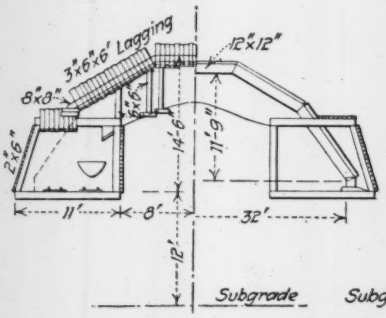

Fig. 2. Stoping Out Between Drifts

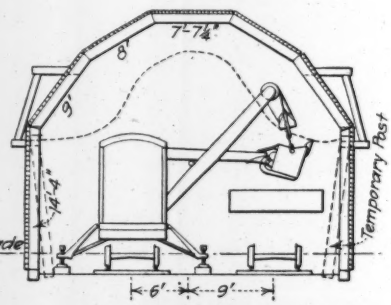

Fig. 3. Placing Five-Segment Timbering

Fig. 4. Excavating Core

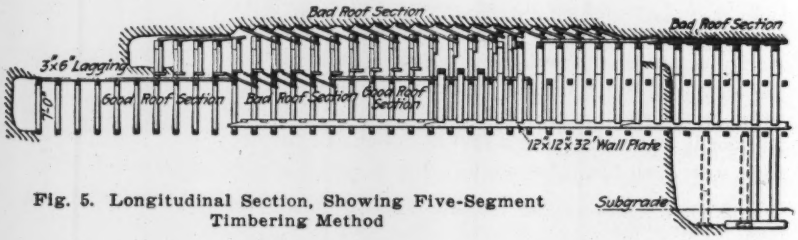

Fig. 5. Longitudinal Section, Showing Five-Segment Timbering Method

FIGS. 1 TO 5. FIVE-SEGMENT TIMBERING IN EAST END, ROGERS PASS TUNNEL

How the work in the rock section was planned to give maximum steam-shovel excavation has already been described (*Engineering News,* Feb. 24, 1916, p. 382). As there stated, the method was chosen for economy of construction cost. That this worked out in practice is shown by the following figures:

If the ratio of overbreak will continue the same as it has in the past, the total excavation in the tunnel proper will be 710,000 cu.yd., omitting quantities in the pioneer tunnel and the crosscuts. The quantities handled by hand will amount to 110,000 cu.yd., or about 15½% of the total, the remainder, or 84½%, being handled by steam shovel.

Steel Dam Eighteen Years Old Still Well Preserved

In the last part of the last century there were signs of the development of a new type of dam—the steel frame with steel plates as a water-retaining surface. Several such dams were built and gave promise of successful use, but for one reason or another they have not been followed by any others. One pronounced objection to the type was the great possibility of corrosion. It seemed probable that the constant wetting to which the dam is subjected would hasten its rusting and early failure. It is very interesting, therefore, to record the condition of such a dam built over 18 yr. ago, and still in successful use.

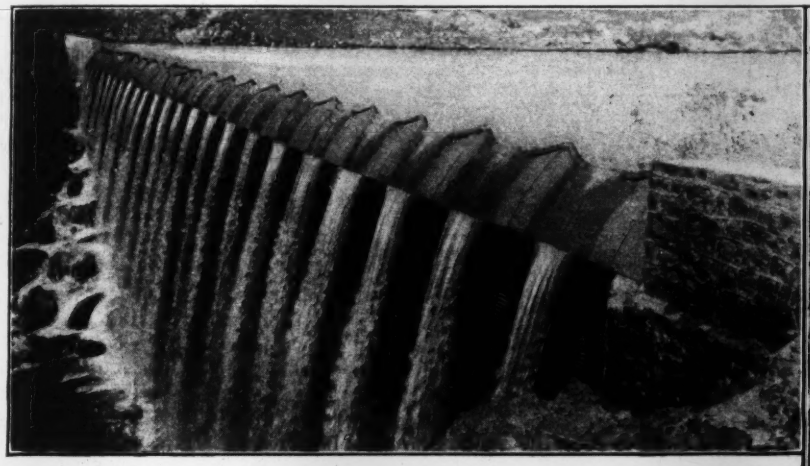

FIG. 1. VIEW TAKEN MAR. 25, 1916, OF THE 18-YR.-OLD STEEL DAM AT ASH FORK, ARIZ.

The Ash Fork dam, situated four miles east of Ash Fork, a station on the Santa Fe Ry., is a steel dam built across Johnson's Cañon in 1898, to store water for the locomotives of the railway. It was described, with a large inset sheet, in *Engineering News,* May 12, 1898, p. 299. The dam is 184 ft. long on top and about 300 ft. in total length. Its greatest height is 46 ft. It consists of a series of vertical steel frames of A-section, footing on concrete bedplates on rock, with an upstream inclined face of steel plates spanning the bents. As shown in Fig. 1, the vertical downstream side of the frames is covered with corrugated iron.

The original coating consisted of two applications of dry red lead and boiled linseed oil. Since then (1898) the dam has been painted but twice, each time with a single coating of Dixon graphite. It is carefully watched for any signs of corrosion and has been painted as frequently as necessary in the judgment of the general foreman of bridges and buildings, who has been on this division (Albuquerque) since the dam was built.

The steel dam is the lowest of a series of four dams in a small cañon, or gully. None of the others is steel. Two are masonry and the latest one (1906) is a curved concrete structure.

There is no reason, judging from the present condition of the steel dam, why this should not have been of the same design so far as permanency goes. The steel dam is in practically as good condition today as when erected.

The general foreman of bridges and buildings, V. C. Proctor, says that except for a few scattered pittings there are no evidences of corrosion except in the bottom plates, which are in contact with the mud of the reservoir.

At the time the dam was inspected by one of the editors (Mar. 25), water was flowing over the crest, but this occurs only at intervals, for the water comes almost wholly from melting mountain snows and summer showers and at times the stream is nearly dry. The object of the four reservoirs is to catch and hold as much of this spring run-off as possible.

FIG. 2. LOOKING ALONG THE CREST OF THE ASH FORK DAM

The face of the dam is water-tight so far as a casual inspection showed. The corrugated plates on the downstream side keep out the spray of the overflow, yet the condensation of moisture in the cold interior apparently keeps the trusses and steelwork continually damp so long as there is water behind the dam.

The base of the structure can be readily exposed and painted without interference with the water-supply, for the water-mains connect with an intake in the dam above, permitting the steel dam to be bypassed.

Public Water-Works Financing

By W. L. Butcher*

From the point of view of engineers cognizant of the physical life and the rate of depreciation of water-works property there exists a considerable inequity in the usual method of financing by means of bond issues running for a moderate term of years.

It is conceived that in the ideal case the life of the bonds should run to the life of the property and that the amount paid off in the later years, when the population and number of consumers is greater, should be larger than in the early years, to the end that the burden should be equally distributed among the benefactors of the utility.

At this point, however, particularly in the case of very long lived structures, such as many of the component parts of a water-works property, conscientious public officials having in mind the financial and economic phases of the matter step in and say that it is not good public policy to postpone for a long period the repayment of bond issues. They view with alarm the rapid growth of debt of communities and consider that, within reason, laws should be so framed that bonds may be paid off as rapidly as possible.

For private properties such a policy may be a sound financial one as in a broad sense it makes little difference to the owners whether earnings are paid in dividends or put back in the property. This policy may also hold to a certain extent in case of special assessments where the whole cost is directly assessed on abutting property and where the value thereof may assume to be immediately increased to the extent of the assessment. With public water-works, however, where large numbers of consumers have no direct or indirect interest in the works and where even the "real" property owners have a very intangible interest, the inequity exists, however much sound "public policy" may insist on the prompt payment of debts.

The attention of water-works officials has been particularly called to some phases of this matter by a recent paper before the New England Water-Works Association on "Municipal Water-Works Financing in Massachusetts as Affected by Recent Legislation."[1]

Massachusetts Water-Works Financing

Under Massachusetts laws bonds for the construction of new water-works must not run longer than 30 years, they must be serial bonds and the payments in any one year must not be less than in any subsequent year. This latter feature has been changed, owing largely to the efforts of the authors of the above paper, so that the first payment on the serial bonds for new works may be postponed for three years.

Briefly the law and engineering exigencies in this particular instance take about the following attitude:

1. If you wish to construct a water-works [illegible] life of the bonds, which is supposed to be of such length as to distribute the burden equitably, shall not be more than 30 years, in spite of the fact that many parts of the structure, after taking into account all the possibilities of physical and functional depreciation, will have a life of 60 or 75 or even 100 years.

2. On account of the engineering exigencies of the case it will be necessary for you to build and commence to pay for works planned, in part, for a population which will only be in existence 30 or 40 years hence.

3. While you should be perfectly ready to build partly for the future, in view of the practical difficulty of doing otherwise, we will further ask you to pay not only an equitable portion based on the probable use of the works today and in the future, but more in the early years than the future generation will pay in the thirtieth year when the population for whom you have magnanimously built these works and over whom the charge will be distributed may be twice as large as today and when interest charges owing to previous payments on the principal will be almost nothing.

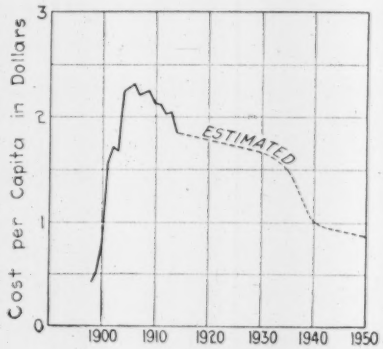

Fig. 1

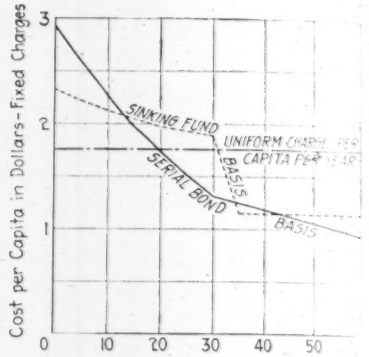

Fig. 2

FIGS. 1 AND 2. COST PER CAPITA PER YEAR, MASSACHUSETTS METROPOLITAN WATER-WORKS

Fig. 1 shows cost per capita per year, including interest, sinking fund and maintenance charges. Fig. 2 shows comparison of charges during 60 years for plant financed by 30-year sinking-fund bonds, 30-year serial bonds and by an approximately uniform charge based on probable population. Works at end of 60 years have same value due to distribution works built during last 30 years

Case of Metropolitan Water-Works

The discussion may be illustrated by the case of the Massachusetts Metropolitan Water-Works, which provides a very good example on account of the probable long life of an exceptionally large proportion of the works. Most of the bonds issued for this work, however, run for 40 years and are of the sinking-fund variety so that conditions are somewhat ameliorated from what would have been the case if the law cited above were in effect.

The original act of 1895 provided that no sums should be assessed on the District until 1898, that $300,000 should be assessed in that year and that an additional $200,000, as well as certain minor adjustments, should be assessed in each subsequent year until the entire amount required was reached and thereafter the annual requirements for interest, sinking fund and maintenance should be collected each year.

In the early years, however, this provision did not furnish sufficient money for operation and such expenses were taken from the loan fund.

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[1]Read before New England Water-Works Association, Jan. 15, 1916.

This situation existed until June 30, 1901, when by a change in the act the whole amount necessary was to be assessed each year. In the first year under the new method, sufficient to repay to the loan-fund money which had been taken therefrom for operation was collected. Thereafter by assessments and premiums the sinking fund increased by leaps and bounds, until in December, 1914, it amounted to $11,533,453, an amount which required additions of only about $250,000 annually to extinguish at maturity the whole debt then outstanding, and at a time far in advance of the expiration of the life of much of the property.

Recognition of the rapid growth of the sinking fund led in 1914 to a reduction in the contribution thereto to $280,333, whereas in some of the earlier years the contribution had amounted to over $800,000 per annum. It is assumed that as far as the original debts are concerned the annual sinking-fund contribution will approximate the former amount from now on.

COST PER CAPITA FOR WATER IN THE MASSACHUSETTS METROPOLITAN WATER DISTRICT

Year	Estimated Population	Charges for All Purposes	Cost per Capita
1898	815,000	$335,800	$0.41
1899	835,000	428,400	.51
1900	856,000	695,700	.81
1901	874,000	1,369,900	1.57
1902	892,000	1,523,600	1.71
1903	910,000	1,536,400	1.69
1904	928,000	2,080,700	2.24
1905	946,000	2,157,800	2.28
1906	972,000	2,243,200	2.31
1907	998,000	2,188,300	2.20
1908	1,024,000	2,271,200	2.22
1909	1,050,000	2,360,700	2.25
1910	1,077,000	2,297,800	2.13
1911	1,101,000	2,333,000	2.12
1912	1,126,000	2,289,500	2.03
1913	1,151,000	2,364,600	2.05
1914	1,176,000	2,173,000	1.85
1940*	2,100,000	2,100,000	1.00

*Estimated.

The estimated population and the amount of money contributed each year by the district and the per capita amounts are shown in the accompanying table. Conditions in the future are of course problematical, but we will assume that in 1940, when all of the bonds for construction of the earlier works have been retired, that the entire present distribution system must be replaced, that the amount of new construction to keep pace with the increased population averages about as at present and that it is necessary to go to new sources of supply at costs already estimated by the Water Board. It seems unlikely that the people of that time will be paying charges on over $25,000,000 worth of bonds and probable that they will be paying on very much less. The charges on this amount, including operation, would approximate $1 per capita of the population of that date.

The fluctuations which the charges per capita have undergone are graphically shown in Fig. 1, and indicate that whereas in the early years a charge of about $0.50 per capita was made and in the future a charge of probably less than $1 per capita will be required; during many of the years the population of the district has contributed at a rate of over $2 per capita.

The inequalities of both the ordinary sinking-fund and the serial-bond method, particularly the latter, are shown by Fig. 2, which gives the results of a computation unnecessary to repeat here, based on a hypothetical case, which assumes a community of 25,000 that increases 2,500 every five years, that the cost of the original works it $1,000,000; one half having a life of 60 years and one half 30 years, and that distribution works are increased by an expenditure of $50,000 each five years.

All of this points to the desirability of the engineer coöperating with officials handling the finances to procure a less unbalanced method of procedure. On its face the sinking-fund method appears less inequitable than the serial-bond method, although best modern financial thought looks with disfavor on this method on account of the danger, unwieldy size and consequent labor involved in administration of those large accumulations.

It is perhaps not possible to lay down any hard and fast rules, but it is perfectly evident that from an engineering and mathematical standpoint it is a simple matter to so compute the annual payments as to distribute the charges in an equitable manner. It remains only to modify the results to such an extent as may be dictated by financial and economic considerations.

It might also be added that these remarks apply with particular force to works of considerable magnitude where from the very nature of the case a long view into the future must be taken at the time of the original design.

Prehistoric Irrigation Ditch Built by Indians

Apropos of the description in *Engineering News* of Feb. 17, 1916, of what is probably the oldest masonry dam in the United States, it is worth noting that the Spaniards were not the original irrigation promoters in the Far West. There exist in several parts of Arizona the remains of irrigation systems that date back to prehistoric days, when some quite highly civilized Indian tribes inhabited these valleys.

One of the most famous of these ancient irrigation works is on the Arizona state highway from Prescott to the Grand Cañon. Water was taken from what is known as Montezuma's Well, a curious natural well 440 ft. in diameter and 93 ft. deep except in one spot where no bottom was reached at 500 ft.

One of the original ditches is shown in the illustration. The water carries a great deal of lime in solution,

ARIZONA IRRIGATION DITCH BUILT BY PREHISTORIC INDIANS

and the sides of the ditch have been preserved by the petrification of the original earth. One rancher at the present time is using several thousand feet of the old ditches, after merely cleaning them out. F. R. Goodman, state highway division engineer, was once tempted by curiosity to run a line of levels along the bottom of one of these old Indian ditches. He found the grade to be almost perfectly uniform at a rate of 0.01 ft. per 100 ft.

Pumping from Deep Wells Into Water Mains at Memphis

SYNOPSIS—Water from deep artesian wells is raised by screw-propeller pumps and forced by a centrifugal pump on the same shaft directly into the mains at Memphis, Tenn. Fifteen wells covering a distance of some 10 mi. are operated in this way, furnishing a supplementary supply to that from the old artesian-well plant, where 60 wells driven in a district a quarter of a mile square deliver water to a central pumping station. By the new system, wells are spaced so far apart that the draft from one well does not affect the flow of underground water to another well.

The City of Memphis, Tenn., is the largest city in the United States (and, so far as is known, in the world) that takes its public water-supply from artesian wells. Underlying Memphis at a depth of 300 to 400 ft. is a stratum of water-bearing sand some 800 ft. in thickness. This stratum, known geologically as the La Grange sands, rises to the surface many miles to the north and east of Memphis and exposes a large area to infiltration. This deep water-bearing sand is the chief reliance for pure water-supply over a large area of Tennessee, Arkansas and Mississippi.

At Memphis this water-bearing sand is overlain by a stratum of hard, impervious clay 150 ft. or more in thickness, as well as softer clays and sands. It is easy and inexpensive, therefore, to sink wells to this water-bearing sand; and the clay stratum around the casing of these wells prevents any percolation of water from higher levels. The water from these wells is pure and cool. Tests show practically no bacteria, and the percentage of mineral matter is very low for an underground water.

The original deep-well plant for public water-supply in Memphis was built for the Artesian Water Co. by the late Thomas J. Whitman, of St. Louis. The first wells were added to year after year as consumption increased, and the works were finally purchased by the city in 1903. Before water was drawn from this underground stratum the water in the wells would rise nearly or quite to the surface. As the draft in the wells increased, however, and especially as a number of wells were sunk within a short distance of each other, the level of the water in the wells fell 40 to 70 ft.

The water from these wells was collected as follows: A 5-ft. tunnel lined with brick was driven in a stiff clay stratum from the main suction well at the pumping station through the district in which the wells were located. From this main tunnel branch tunnels were run with wooden-lined drifts 30 in. high and 40 in. wide to the individual wells. These drifts were 80 to 90 ft. below the ground surface, and the water from the wells flowed by gravity through the drifts to the tunnel and then to the pump well.

The principal difficulty experienced in the operation of this system was the steady deterioration or falling off in yield from the wells. An extended investigation and report on this deterioration was made in 1902 by a commission of engineers and was published in *Engineering News* of Sept. 25, 1902. At that time 104 wells had been sunk by the company, and the first 42 of these had been abandoned after about 10 years' service. The falling off in yield was due partly to a gradual clogging of the sand surrounding the well. At the bottom of the well casing is placed a "Cook" well strainer about 50 ft. long, a cylinder of brass pierced with very fine slots 0.01 in. in width. It has been found that after a well has been a long time in service a peculiar incrustation builds up on the outside of this strainer and shuts off the flow of water. The cause of this incrustation is not fully determined. Various methods have been adopted from time to time for cleaning the strainers. One method is forcing water down the well to induce a reverse flow through the strainer. The most common practice, however, is to pull the casing out of the well and clean it—a rather expensive job.

The most serious situation in connection with the Memphis wells, however, was the limitation in the amount of water available in the territory reached by the tunnel system. The report of the engineering commission referred to stated that the area covered by the well system then in existence was only about one-quarter of a square mile. The commission stated that no matter how many additional wells might be sunk in this territory the amount of water economically available from it would not be much increased. The commission foresaw that the growth in population and demand for water would eventually require a duplication of the group of wells, tunnel system, pumping plant, etc., in some other district some miles away, where it would not interfere with the supply of water to the old wells.

It was evident that such duplication of the whole water-collecting and pumping plant would require a large outlay, and a further obstacle to its establishment was that the stratum of impervious clay in which the first collecting tunnel is driven is not found at the right depth in other parts of the city.

As soon as the city took over the works in 1903, experiments were undertaken having in view the pumping of water from individual wells directly into the mains, and a pump suitable for such work was designed by the late Thomas T. Johnston, of Chicago, at that time consulting engineer of the Memphis works. This pump proved unsatisfactory, however, and the increasing demand for water made it necessary in 1906 to install air lifts in three wells in the southern part of the city to supplement their flow. A difficulty in the use of the air lift at Memphis, however, is that the water contains a very small percentage of iron, which remains in solution when the water is first drawn from the well, but is precipitated when the water is exposed to the air.

Experiments with apparatus for pumping directly from the wells were continued, and in 1910 a well was equipped with a pump designed by Wirt J. Wills, superintendent of the Memphis water-works. In 1911 four additional wells were drilled and equipped with this pump; seven additional wells were added in 1912, and three in 1913. Fifteen wells in all are now equipped with pumps of this design; and instead of being grouped in a small

area, as are the old wells, the new wells are scattered along an irregular line for a distance of about 10 mi., as shown in Fig. 3. The distance apart of these wells varies from 1,000 ft. to over 6,000 ft. With wells located so far apart, the draft of one well has no appreciable effect upon the flow of water to other wells. Each of these wells is capable of a yield of about 1,000,000 gal. per day.

Each of them is equipped with a motor-driven centrifugal pump on a vertical shaft that extends down the well and carries a series of screw propellers. Between the screw propellers are roller bearings for the shaft and guide vanes that arrest the whirling motion of the water due to the rotation of the propellers. The shaft carrying these screw propellers is made up in 4-ft. sections joined by screw couplings. The guide vanes are secured in a tube, which is also made up in 4-ft. sections. The whole apparatus is built up section by section and lowered down the well casing until the lowest section is below the normal level of water in the well, when flowing at its maximum rate.

The electric motor is a constant-speed induction motor developing 100 hp. at 850 r.p.m. The centrifugal pump has a 28-in. impeller and can deliver water at a pressure of about 60 lb. per sq.in. The motor and pump are placed in a concrete chamber underground and are reached through a manhole on the street surface. The motor is thoroughly protected by automatic appliances that, in case of overheating of the coils or the bearings, cut off the current supply and stop operations. Two men on motorcycles—one for the night shift and one for the day shift—make the rounds of these 15 pumps regularly and attend to lubrication, etc. A venturi meter is placed on the delivery main from each well, so that its output is recorded. It is claimed that in a test recently made of one of these pumping units a total efficiency of 50% was attained for the combined motor and pump equipment.

It will be evident that with this system of individual pumping units ideal conditions of pressure distribution are attained, and a minimum expense is required for street-main construction. Each well supplies normally the demand from the district immediately around it, but the mains being all connected in one general system the surplus delivered in any district where the consumption may fall below the delivery will be delivered to other districts. It would be apparent also that the centrifugal pump, which increases its output as the head drops, is admirably suited for use with this system. Details of the pumping machinery are shown in Figs. 1 and 2.

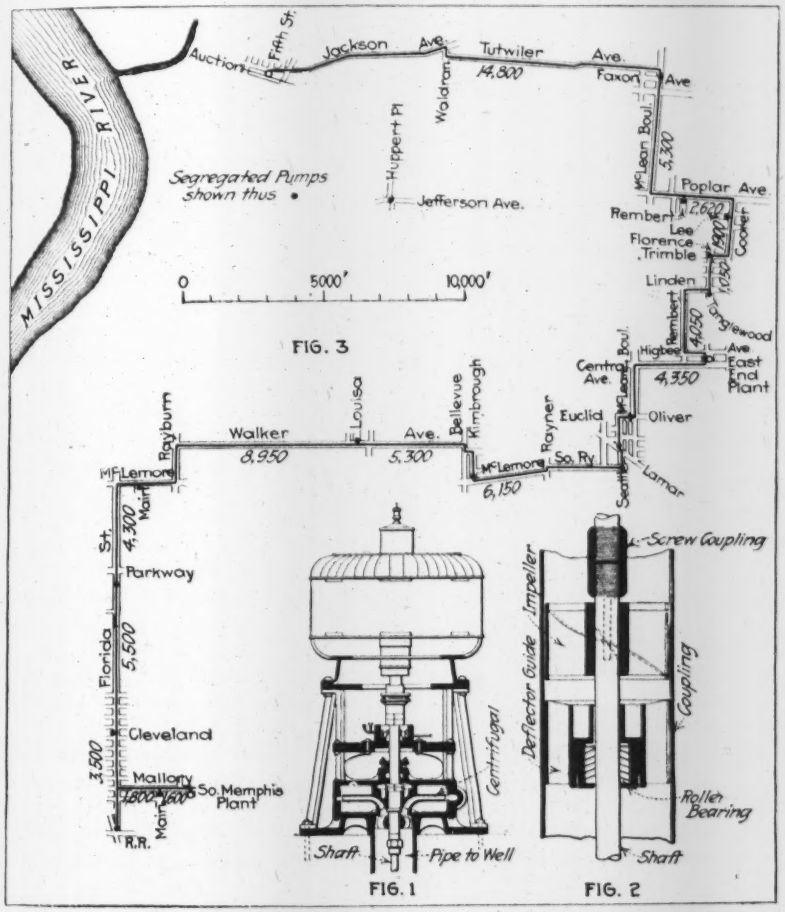


FIG. 3 FIG. 1 FIG. 2

+FIGS. 1 TO 3. DETAILS OF DEEP-WELL SYSTEM AT MEMPHIS

Fig. 1—Elevation of electric motor and centrifugal pump at top of well. Fig. 2—Vertical section through screw-propeller pumping system for deep wells designed by Wirt J. Wills. Fig. 3—Sketch map, showing location of individual deep wells for water-supply of Memphis

Mr. Wills applied for a patent on this system of pumping on May 23, 1910. There were long delays and interference proceedings in the Patent Office, however, and the patent was not issued to Mr. Wills until Mar. 14, 1916. Its number is 1,175,856. The patent contains exceedingly broad claims. One of them, for example, reads as follows:

> A fluid-pumping mechanism, consisting of a screw-propeller lifting member capable of raising the water from below the point of suction lift, and a centrifugal pumping element of the same capacity as the lifting member, and arranged in position to receive the discharge from the lifting element and a motor connected with said lifting and pumping elements.

Whether Mr. Wills can sustain his claim to being the pioneer in developing this system of pumping from deep wells directly into the mains remains to be seen. Readers who are interested will find a valuable paper on "Methods of Deep-Well Pumping," by C. B. Burdick, of Chicago, read June 5, 1907, before the Western Society of Engineers and published in *Engineering News* of July 18, 1907, p. 54. In that paper Mr. Burdick referred to some early work in the design of deep-well vertical-shaft centrifugal pumps done by John W. Alvord in 1902, Prof. D. W. Mead, of the University of Wisconsin, Byron Jackson, of San Francisco, and P. J. Wood, of Los Angeles, Calif. The American Well Works, of Aurora, Ill., has also been active in this field.

Whatever the final adjudication as to patent rights on the system may be, the work at Memphis is of great interest, as it is doubtless the largest installation ever

made on a city water-supply of pumping from individual wells directly into the mains.

Especially noteworthy at Memphis is the satisfaction which this system gives to the water consumers. In the long and intensely hot summer, water distributed through street mains in Memphis from the old well system becomes very warm, and on exposure to the air in its passage through the drifts, collecting tunnels, pump wells, etc., some iron is deposited. The water from the independent wells, on the other hand, comes from the sand at a temperature of about 55° and passes so quickly to the consumer that little heat is imparted to it and there is no chance for aëration and deposits of iron. It is difficult to convince the consumers in the districts supplied from these independent wells that they are not being supplied with water of superior quality from an entirely different source than the water supplied to parts of the city served from the old well system.

Erection of Old Trails Bridge Over Colorado River

By J. A. Sourwine*

SYNOPSIS—Long-span steel arch trusses built in horizontal position with end hinges in place, and one half-span overlapping the other at center. Half-spans, weighing 150 tons, then hoisted into position at center hinge by means of temporary central tower supported on pile bents and constructed from material later used in bridge floor system.

The "Old Trails" arch crosses the Colorado River on the route of the national "Old Trails Highway," at a point about 12 mi. below the town of Needles, San Bernardino County, Calif. The bridge consists of one main span—a three-hinged arch, of length 592 ft. c. to c. of end hinges and width 25 ft. c. to c. of trusses—and approaches, each consisting of two 56-ft. plate girders supported on steel towers. The main-span floor extends 8 ft. beyond end hinge to the approach girder. Thus the total length of bridge is 832 ft.

Certain unusual features in the design were made the basis by the contractors for a rather novel method of erection. The end hinges are of ordinary pin type. The center hinge is of ball-and-socket type, with spherical compression bearing. A steel casting with milled head and convex spherical bearing surface serves as the male portion of the center hinge. A cast-steel hood with cylindrical hole or pan, to receive a flat cylindrical nickel-steel compression piece, one face of which is a concave spherical surface which takes thrust from the male half while the other face distributes the stress to the hood, constitutes the female portion of main center hinge. Adjustment is provided in the shape of cylindrical steel shims of varying thickness, to be inserted in the pan of the hood, back of the nickel-steel compression piece.

Four auxiliary leaf hinges are provided, each consisting of four 3½x6-in. angles riveted to the sides of upper and lower chord, with 6-in. legs horizontal, and spaced to allow the insertion of a 6x½-in. steel plate which was inserted after the trusses were in place. These plates form leaf hinges flexible under rise and fall of arch, as caused by temperature changes, but acting as a tensile member against any tendency to separation at the leeward hinge under wind pressure.

Both the peculiar type of center hinge and the unusual natural features of the crossing were taken advantage of in planning the erection. At low water a sand bar extended out into the river from the Arizona side about 220 ft., from which point the silty temporary bottom of the river sloped gradually out to a depth of about 8 ft. below the surface of the water, thence more abruptly to 12 ft., and thence again gradually to a maximum of 30 ft. below the surface of the water, about 65 ft. from the California hinge.

Soundings taken during the preliminary survey showed rock to slope away rapidly on each side of the river to a depth of over 80 ft. below low water. The filled bottom of the river showed to be in most part silt and very fine sand. Some thin gravel strata were encountered at depths varying from 30 to 50 ft. At a depth of about 42 ft. one gravel stratum was reported as having a thickness of 1 to 2 ft.; this was recommended by the writer as the minimum depth for support of the erection falsework.

The engineer of the Kansas City Structural Steel Co. conceived the idea of driving piles out into the river as far as scour of current would allow and erecting the trusses in approximately horizontal position, with end hinges seated, and then raising them into position by a central temporary tower supported on pile bents, material from the bridge floor system to be used for the construction of this tower.

In accordance with this scheme the main abutments were first constructed, the end hinges set in place, the trusses on the Arizona side built out on a sand bar from that side, and continued to the center hinge on piling driven in shallow water to a distance of about 70 ft. beyond the end of the sand bar. The California end hinges were then set in place, and piling was driven from the Arizona bank to within approximately 60 ft. of the California hinges. The trusses on the California side were cantilevered out across the gap and then built up on the piling. Near the center hinge the two halves of the bridge overlapped, the California half lying on top of the Arizona trusses previously constructed, as shown in Fig. 3.

Vertical and diagonal members were riveted in place and all chord joints riveted up. The lateral struts and lateral diagonal rods were bolted loosely in position, so as to allow of some slight movement between the trusses during erection. Sufficient lateral bracing near the center hinge was left out to allow the half-spans to clear the erection tower, which was built in the clear width between trusses, as shown in the view in Fig. 4.

*Designing Engineer, "Old Trails Bridge," member of Sourwine & Mahoney, Consulting Engineers, San Bernardino, Calif.

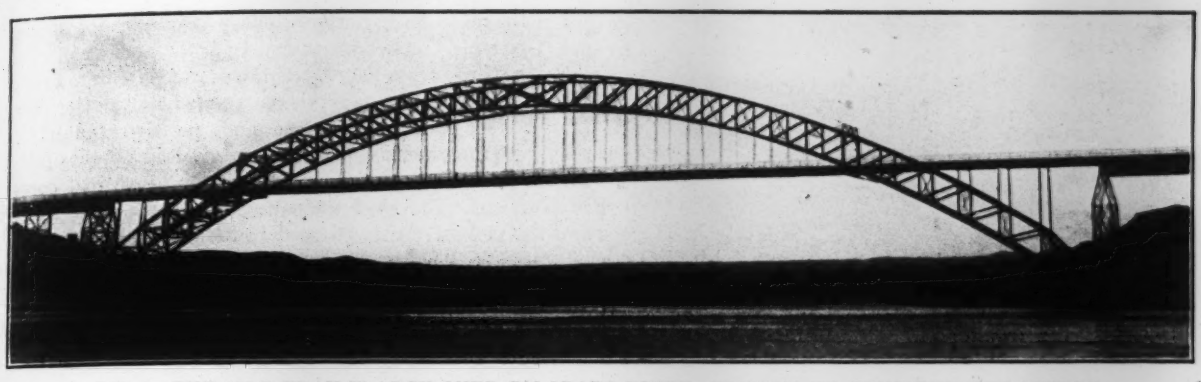


FIG. 1. THE "OLD TRAILS" ARCH OVER COLORADO RIVER; SPAN 592 FT. BETWEEN END HINGES

The erection tower was built up almost entirely of members taken from the bridge floor system. The columns were framed in the shop to the lengths desired for the tower and cut afterward to the lengths desired for use in the bridge.

The foundation consisted of 36 piles (9 at each corner) driven to an average penetration of 42 ft. and cut off 2 ft. above low water. This piling was capped with fir timbers; bridge floor stringers consisting of 12-in. I-beams were laid transversely across these timbers to aid in distributing the load on the piling, and 24-in. I-beams, later used as bridge floor-beams, were laid transversely across the top of the distributing beams, to serve as supports to which were bolted the columns of the tower. The columns were constructed from sections of the wind chord of the bridge. The horizontal bracing of the tower consisted of 24-in. I-beams longitudinally and 12-in. I-beams transversely, the sway bracing of single 3½x3½-in. angles with special bent-plate connections. Bolted connections were used throughout.

Three 20-in. 65-lb. I-beams were used on each side of the tower parallel to the bridge for loading beams. Each set of these beams rested on special cap plates on the columns, the beams of each set being bolted together with 8-in. channel separators. The raising beams, laid transversely across the top of the loading beams, consisted of four 24-in. 80-lb. I-beams, one pair on each end of the tower, each pair spaced 4½ ft. and bolted together with four 12-in. channel diaphragms. On top of the raising beams was placed a special connection for the top load block, two short lengths of 15-in. channel riveted together, with 2¾-in. separators between them. These channels were placed 2 ft. 9 in. on centers on each end of the raising beams, and fastened to the latter with ¾-in. machine bolts. The connection for each load block was two 4-in. pins through the webs of the 15-in. channels.

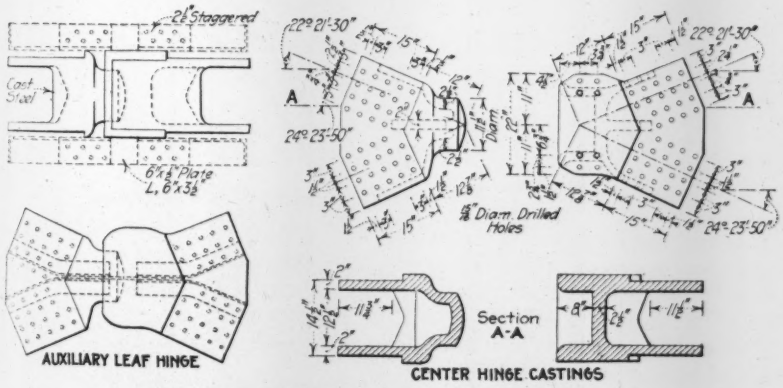


FIG. 2. CENTER-HINGE CASTINGS AND AUXILIARY LEAF HINGE

The two halves of the arch were hoisted successively, the California half first. Two sets of load blocks and cables and two 30-hp. hoisting engines were used—one for each truss of a half-span. A separate connection was made for the upstream and downstream trusses, which were hoisted independently and kept even by regulating the relative speed of the two hoisting engines. The load line, ⅝-in. wire rope, was reeved through the blocks so that both ends came out on the same side of the top block. These ends were brought to the foot of the tower and passed through gate blocks lashed to the piling, the two ends of each cable being then run out horizontally and attached to separate drums of the hoisting engine. The use of two drums on each hoisting engine made possible considerable economy in size of hoisting engines used, the load being hoisted about halfway on one drum and dogged, and the other drum then used to raise the load to the desired height.

Two sets of four 2½-in. bolts 20 ft. long, with threaded length of 6 ft. on each end, were also suspended from the channels used to support the load blocks, at the two corners of the tower nearest the California shore, for use as slings for supporting the end of the California trusses after raising. By the use of these bolt slings, the necessity of two extra sets of blocks was avoided, the Arizona half-span being raised with the two sets of blocks while the California trusses were in the slings.

Owing to the unusual method of truss erection and the lack of precedent for any work of similar magnitude, and also to the well-known undependable character and shifty nature of the Colorado River bottom and some consequent degree of uncertainty with regard to the stability of the tower foundation, it was thought best to exercise unusual caution in the work of raising the trusses. After all connections were completed ready for raising, the load block connections were made for the California trusses and the center-hinge end was raised about 2 ft. clear of its ground supports—the span then

FIG. 3. THE HALF-ARCHES OF TRAILS BRIDGE ON FALSEWORK BEFORE RAISING

hanging with one point of support at the end hinge and the other at the pin connection, transferred by load blocks to the erection tower. As a preliminary test of the erection-tower foundations, the California trusses were left suspended over night in the position described. Observations of the base of tower showed a maximum shift of position of only 0.01 ft. elevation, at one corner of tower, during this 16-hr. suspension. This test was felt to be satisfactory evidence of the stability of tower foundations, and the work of erection was continued.

The California truss was raised first and was eased into the slings, with center-hinge end in position slightly above that previously determined by calculation as the proper height, to allow for clearance required in raising the other half-span. The load blocks were then shifted to the other side of the tower and used to raise the Arizona half-span. The actual raising time for the first half-span was 20 min., the elapsed time 45 min. The actual raising time for the second half was 17 min., the elapsed time 32 min. About six hours was required for easing the first half into the slings and transferring connections to the other half-span. The entire work of raising trusses was done in one day.

It had been hoped to complete the truss erection in one day, by easing away the trusses till the center hinge came into bearing, but several unexpected delays made this impossible, and the two half-spans were accordingly left standing over night, with the California trusses in the slings and the Arizona trusses suspended by the load blocks.

On the following day the center-hinge ends of the two half-spans were lowered alternately, using the blocks and lines for the one half-span and the slings for the other, until the center hinge came into proper bearing. The total time of lowering into position was about six hours. Cables and slings were then slacked off and the trusses allowed to assume their own full weight. The center plates of the auxiliary leaf hinge were riveted in place, and work was started on dismantling of the erection tower and construction of the bridge floor.

Credit must be given the bridge company for unusual care and good workmanship in both fabrication and erection of the truss members. Measurements were made under the writer's supervision immediately after the trusses had been lowered into final position and while they were under initial load (their own dead weight only) to determine how accurately the center hinge had come to position. The steel temperature was taken carefully and the measurements reduced to the design temperature of 90° F. The result showed the center hinge of the upstream truss to be 0.05 ft. high and the center hinge of the downstream truss 0.03 ft. high, or an average of 0.04 ft. high for both trusses at the center hinge. As to position, the trusses were found to be approximately $\frac{3}{8}$ in. upstream at center—about what was to be expected from the slight difference in height at upstream and downstream hinges.

The ratio between increment of vertical ordinate at center, for small rise or fall at center hinge, and the corresponding increment of long chord of half-span, for arch of 592-ft. span and 100-ft. rise, is 3.24 to 1. Using the maximum error in height of center hinge of 0.05 ft., as found, the long chord of the half-span would appear to check within $\frac{3}{16}$ in. of the design length. This is a most unusual fabrication record for such a length of span.

Observation of the behavior of the tower during the erection of the trusses, made by transit from a point 200 ft. upstream on a line nearly at right angles to bridge, showed a maximum variation of top of tower from true vertical to be about 3 in. The greatest movement occurred when the California truss was resting in the slings and the Arizona truss was between one-half

FIG. 4. CALIFORNIA HALF OF ARCH SUSPENDED IN STIRRUPS AT TRAILS BRIDGE

and two-thirds of the way up. At this period there was a definite uplift observable in the columns on the Arizona side of the tower, and it was thought necessary, as a precaution, to tie down the Arizona legs of tower. This done, the raising of the truss proceeded, and as it rose higher and the direction of pull due to load again approached the vertical, the deflection of the top of the tower grew less. When the second truss had been raised to the proper height, the tower had again assumed its correct vertical position.

Some bending and snapping due to reversal of stress was noticeable in the long diagonals on the sides

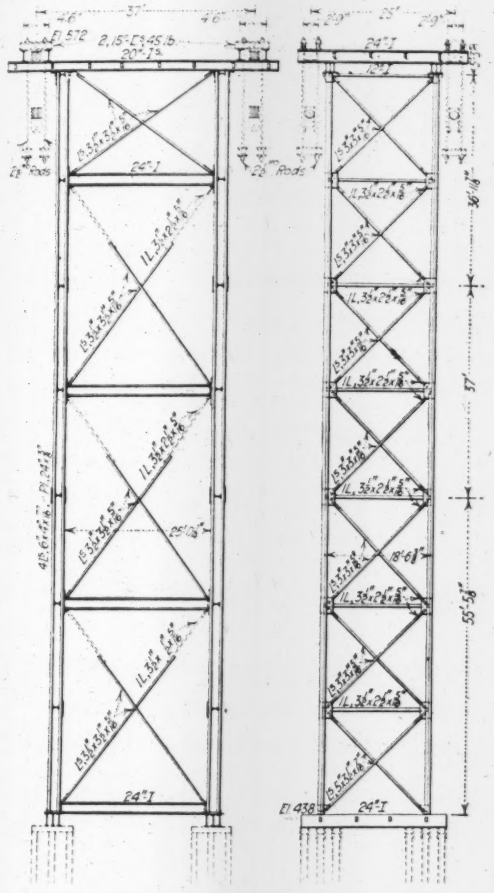


FIG. 5. SKETCH OF ERECTION TOWER

Steel shown in solid lines was part of bridge floor framing. Steel shown dotted fabricated for tower alone

of the tower during the raising, and there is no doubt in the mind of the writer that stronger and heavier diagonals should have been provided for proper factor of safety in erection design. An additional factor of safety could also have been provided by increasing the length of the tower parallel to the bridge. It should be borne in mind, however, that the intent of the bridge company was to build the tower entirely from material already on the ground for use in the bridge, and that the tower actually was so built with the exception of some splices of the diagonals, the short loading beams and some minor items in the way of connections.

Taking together the bold erection method, the accuracy of fabrication and the erection without accident, the work deserves unusual mention.

The bridge was built by the Kansas City Structural Steel Co., under Thomas McCurnin, Construction Superintendent. The contract was let through the United States Commissioner of Indian Affairs, June 30, 1915, and the structure was finally accepted Feb. 20, 1916. Design and superintendence were by the writer. J. P. Kemmerer acted as the writer's personal representative on the ground during construction and fulfilled the joint duties of inspector and construction engineer. The details of erection were worked out by A. M. Meyers, Architectural Engineer, Kansas City Structural Steel Co. The total contract price, excluding end wing walls, which were built by the respective counties on each side of the river, was $75,448. This amount does not include either cost of design or supervision of construction.

Legal Decisions of Interest to Engineers

Construction of Excavating Contracts—(Massachusetts). A contract requiring the contractor to excavate all "soil, earth and stones" does not oblige him to excavate a ledge of rock not known to him at the time he signed the contract. Where a contractor does work not within the scope of his contract, and the owner knows that the work is being done, assents thereto, and receives the benefits, although erroneously believing the work is covered by the contract, a court is warranted in finding that the contractor is entitled to recover for the work. (Howard vs. Howard, 112 N. E. 233.)

Construction Company Entitled to Lien—(Illinois). Under Illinois law relating to public improvements, it is not necessary that material furnished shall be entirely used in a public improvement to establish a lien against the money in the hands of a city due a construction company. The lien runs, not against the property or improvement, but against the fund in the hands of the city. The court in Alexander vs. City held that the construction company could recover for materials furnished a city though some of such material was not used on city work. (Alexander Co. vs. City , 111 N. E. 1017.)

Cannot Recover Cost of Making Tests—(New York). Where a contract for the equipping of a pier with machinery provided that, when the equipment was sufficiently completed to require the operation of the electric generating plant, the contractor should furnish a competent crew to operate the plant for a period of six days during which time proper tests should be made, the contractor could not recover from the city for coal and labor used in operating the plant to make the tests. (N. E. Const. Co. vs. City of New York, 112 N. E. 53.)

Surety Company Held Liable—(Kansas). Failure to comply with a provision in an indemnity bond issued by a surety company, which required the obligee to give written notice of the default within 10 days after learning of the fact, is no defense to an action on the bond, where it is neither claimed nor proved that the company suffered any loss or damage from the failure to give notice. Here a company failed to perform its construction contract. The plaintiff failed to notify the surety company of this within the stated 10 days and the surety company claimed a discharge from liability on the bond. The Kansas Supreme Court held the surety company not discharged from liability. (McClure vs. Freeborn Engineering Const. Co., 156 Pac. 692.)

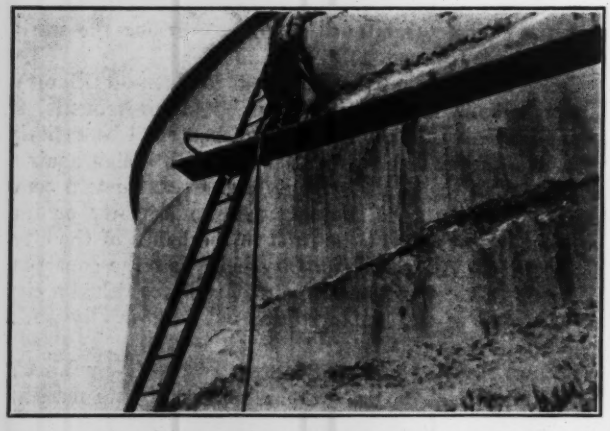
Field and Office

Waterproofing a Concrete Tank with the Cement Gun

By N. F. Ambursen*

The writer has just successfully completed the waterproofing of a reinforced-concrete tank 75 ft. in diameter and 30 ft. high, which in common with many other similar structures has shown decided leakage since its construction about nine years ago. Two different waterproofing materials had been used on the inside and utterly failed to obtain results. They consisted of two layers of some kind of waterproofing on the inside of the tank, each layer about 1½ in. thick. After each application the tank was filled and stood for a year or more. The leakage, instead of diminishing, seemed to increase, and when the writer first saw the tank, water was pouring out in streams away from the walls.

After this sad experience the owners called on the writer to specify a waterproofing and repair the tank so as



DIGGING THE BAD CONCRETE OUT OF A CRACK IN WATER TANK

to put it in good condition. It was deteriorating very fast and would not have stood many more years before it would have been beyond repair. The original thickness of the walls was 12 in.

The tank was emptied, thoroughly cleaned and dried with charcoal salamanders. The interior surface of the wall was then coated with a hot elastic asphalt on which a three-ply felt was applied with asphalt mopped between layers, and the whole surface was mopped with a last coat of asphalt. A curtain of wire mesh was then hung from the top of the wall to the bottom, covering the asphalt, and the surface was coated with 1 in. to 1¼ in. of gunite—that is, concrete shot on with a cement gun—as protection for the felt and asphalt. This waterproofing extended about 10 ft. onto the floor of the tank, which was also coated with gunite, but without reinforcement. The tank was filled and found to be water-tight.

*The Ambursen Co., 12 West St., Boston, Mass.

The outside of the tank did not have a bad appearance; there were some cracks along the field joints, but there was no flaking of the concrete or much indication of bad concrete. It was decided, however, to clean out these joints and fill in with gunite, as there seemed to be pockets that might hold the water after it rained. We used for this purpose a small air-drill, and in our first attempt to open a joint or seam we found the interior concrete like a pocket full of sand. The exterior shell of about 1 in. to 1½ in. seemed to be firm and hard and composed of a rich mixture of sand and cement, but in several places the chisel went in with one stroke of the hammer up to its length, which was about 8 in. In some places we had to go through the whole thickness of 12 in. until we struck the waterproofing, which also seemed to be hard and firm. After all seams were chiseled and all loose material removed, we refilled with gunite and the tank was left as good as new—in fact, far better than when it was built.

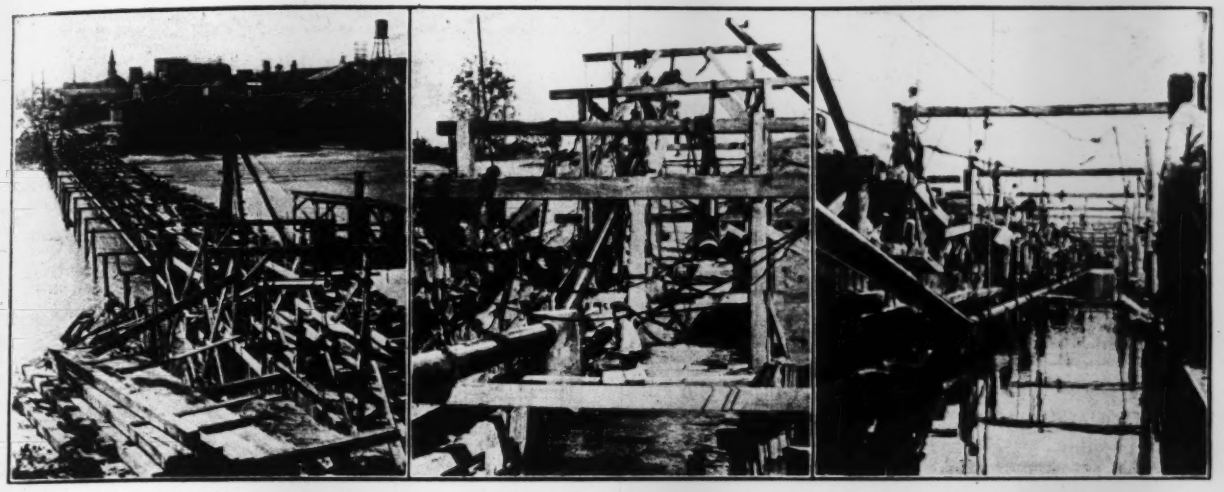
Another important fact that came to the writer's notice, not only on this tank but on others, was the concrete around the reinforcement bars. He has maintained for many years that square bars over 1 in. thick should not be used in walls less than 12 in. thick. In this particular tank and others the writer found that the larger bars were not surrounded with concrete and found underneath the bars pockets in which, in some places, he could insert a ⅜-in. rod and run a wire along the rod for a distance up to 1 ft. These pockets evidently collect water, and those nearest to the outside face freeze and expand to such an extent that the concrete finally breaks.

Two Welded Gas Mains Laid Under Brazos River

The recent successful laying of two 10-in. gas mains under the Brazos River at Waco, Tex., is of unusual interest because of the long lengths of welded pipe that were dropped into place, because of the depth of subaqueous trench required to eliminate washing out of the lines, and because of precautions necessary to prevent rapid rises of the river from wrecking the work while under way. Twelve electric cables were laid in the same trench as the pipe.

The river bottom was found to consist of rock under 8 to 10 ft. of coarse sand and gravel, and over the latter about 12 ft. of alternate layers of quicksand, clay and fine sharp sand. The trench was therefore carried down to gravel clear across the river. Substantial falsework was erected to carry a traveling combined piledriver and derrick. Wakefield sheetpiling was driven on the upstream side of the trench and braced to the falsework.

The 20-ft. lengths of pipe (⅜-in. wall and 10-in. diameter) were welded up into 100-ft. lengths in the approach ditch on the west side of the river, and at about the level of the top of the falsework. This was done with oxyacetylene torches, the gas supplies coming from portable cylinders ("Prest-O-Lite" dissolved-acetylene system) moved from point to point as needed. Since



FIGS. 1 TO 3. PUTTING A 10-IN. GAS MAIN UNDER THE BRAZOS RIVER AT WACO, TEX.
Fig. 1—General view of falsework and suspended main. Fig. 2—Finishing drip pocket at shore end of first line; pipe ready to drop. Fig. 3—Welded pipe floating

beveled-end pipe had not been ordered, a butt-weld was necessary, the pipes being set 3/8-in. apart and the space filled with Norway iron. About 45 min. was required for each joint, compared with 30 min. for work where beveled ends have been used. The joints were first tested by bending, placing a block underneath and a man on each end; then the pipes were put under 90-lb. pressure.

After the 100-ft. lengths of the subaqueous section (550 ft. in all) of the first line were completed, they were pulled out over the river on the falsework for the final welds, which were rushed through. The welder was followed by a man coating the pipe with asphalt. Then burlap strips were wound on and coated with asphalt. A final layer of burlap and coat of asphalt were added.

Cast-iron drip pockets were ordered, but on receipt proved to be porous, so that new pockets were made of boiler-plate sheets welded up on the spot by the oxyacetylene equipment. The pockets were 24 in. in diameter and 5½ ft. high.

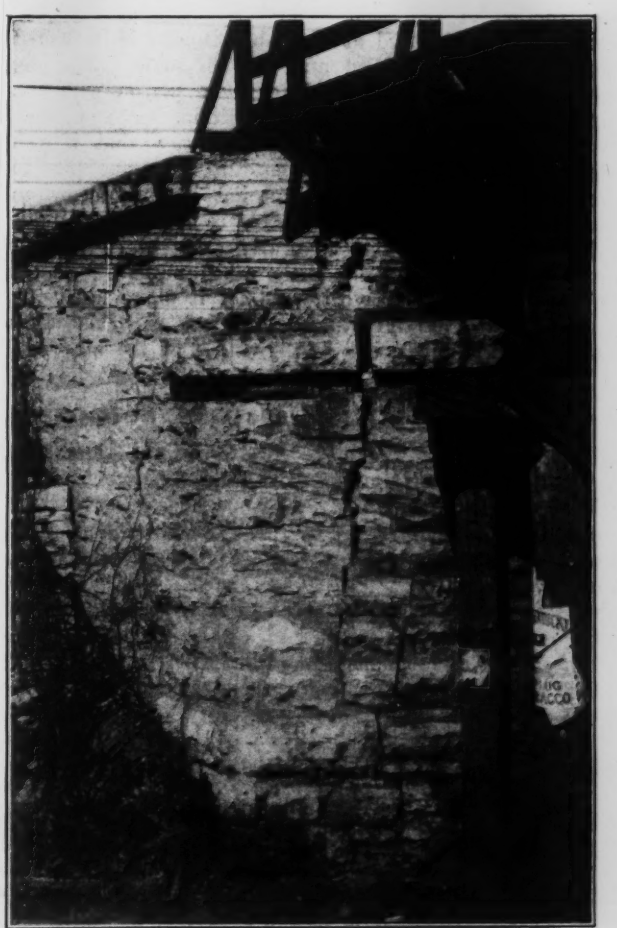
The line was lowered by block and tackle until it floated on the water inside the falsework. Then the pipe was loaded with 115 lb. of steel sheetpiling on each 20-ft. section to sink it into place. This entire procedure was repeated for the second main, and the electric cables were pulled across.

The total cost of the welding for this job is estimated at $650, including the services of one skilled welder for the equivalent of 38 days at $5.60 per day, the man's expenses, 3,600 cu.ft. of oxygen and 3,400 cu.ft. of acetylene--both at 2c. per cu.ft. The work was done under contract by the Phœnix Construction Co., of New York City, B. Diem, engineer in charge.

Fractured Bridge Abutment

The masonry bridge abutment shown in the accompanying view is on the Rock Island Lines at Newton, Iowa, the plate-girder bridge carrying the tracks over the main road approaching the station. The abutment is of stone masonry, of U-shape, and is cracked in both the main wall and the wing wall, the cracks being in line with the backs of the walls. The widest crack is in the main wall.

This is one of a number of similar abutments built 30 or more years ago. Several of these have cracked in the same way, though as a rule only one crack occurs (either in the main wall or wing wall), this being always in line with the back of the other wall.



MASONRY BRIDGE ABUTMENT CRACKED THROUGH MAIN WALL AND WING WALL

How To Store Cement

By S. P. Baird*

It is sometimes thought that only one thing is necessary for the safe and effective storage of cement—a tight roof. Many years' experience has convinced the writer that water-tight storage is not enough, and he has formulated the following principles for cement storage:

1. Cement will retain its strength for an indefinite period when stored in air-tight containers.

2. Cement will be injured less by storing in paper sacks than in cloth sacks, everything else being equal.

3. Cement in any kind of commercial packages will be injured least while in storage if the packages are piled as closely together as possible. In other words, the outside surface of the pile of sacks should be the smallest amount possible.

4. Piles of cement sacks should be covered with a tarpaulin to prevent as far as possible the circulation of air through the pile.

Note the word "tarpaulin"; an ordinary canvas cover is not a tarpaulin, but a paulin. Five parts coal tar, one part gasoline and one part good japan drier make a water-tight black coating for canvas.

Surface condensation often takes place on a stored sack of cement. The moisture is carried into the cement to its very great injury as well as the practical destruction of the sack. The destruction of the sack may not be evidenced at once; but it may be returned to the mill and refilled and sent to some other job, where it bursts and is paid for by a person who was in no way responsible for its condition.

There is a saying among cement men that if you turn your cement—that is, move it from one pile to another—once a month, it will not be injured by an indefinite period of storage. This is not the case; pile it closely and cover it as nearly air-tight as possible and you will have very little caked cement. If the cement is caked it is better to let it alone until you are ready to use it rather than break the cake, thus presenting fresh cement to the action of the air.

Subaqueous-Tunnel Record

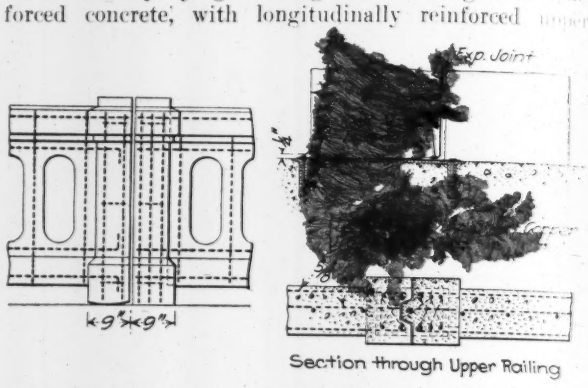
Rapid advance was made in driving the Dorchester rapid-transit tunnels under Fort Point Channel, Boston, Mass. The best month's run in one tube was 375 ft. of completed tunnel. A. A. Cahill discusses the progress of this contract in the May *Journal* of the Boston Society of Civil Engineers. The average run for the best three months was 325 ft. per month, a large portion of this being in hardpan. Mr. Cahill claims that this establishes a record for subaqueous tunnel driving. All spoil had to be brought through the shield and out of the locks.

No provisions were made for cooling the air when the air pressure was first placed on the tunnels, which was early in June, 1915. Shortly afterward, however, after-coolers were installed. The design chosen was 3 ft. in diameter by 12 ft. long, with about one hundred and twenty 1½-in. brass tubes, through which harbor water was pumped. Air from the compressor passes into the after-cooler, where it is cooled, expanded and then carried on to the heading through an 8-in. steel pipe.

*Engineer and Contractor, 315 Ninth Ave., Columbus, Ohio.

Expansion Bearing for Concrete Bridge Railing

In some of the reinforced-concrete bridges recently built by the City of St. Louis, Mo., the expansion in the railing is taken care of by the special joint shown in the accompanying drawing. The railing is of reinforced concrete, with longitudinally reinforced upper



EXPANSION BEARING ON BRIDGE RAILING FOR ST. LOUIS BRIDGES

and lower rails spanning between posts and a panel with close-spaced openings. At the expansion joint the post is split vertically and the bottom of the movable half is provided with a curved base sheathed with copper, which slides on a base plate of copper embedded in the sidewalk slab. The design was made by C. R. Martin, under L. R. Bowen, Bridge Engineer.

Staking Out Retaining Walls on Curved Alignment

By Livingston Leeds*

In staking out on steep slopes a curved retaining wall with a batter on the face, it is often troublesome to secure good alignment for the top, especially when the foundation depths vary and the top is on a grade. The curves

*Assistant Engineer, New York State Highway Department, 321 St. Nicholas Ave., New York City.

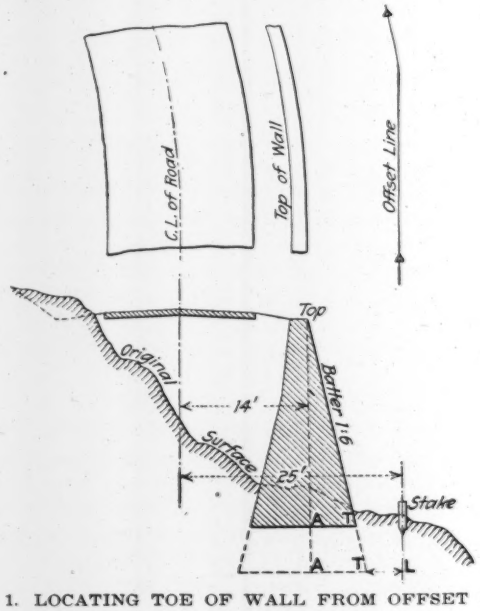
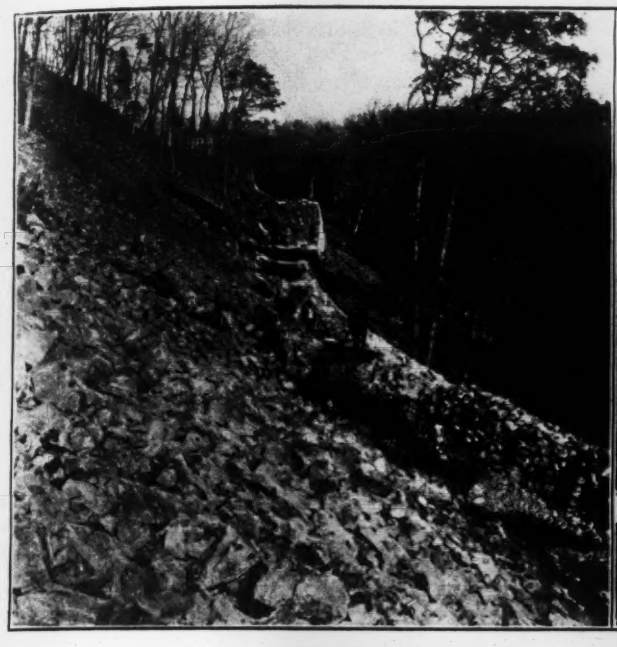


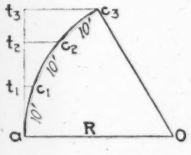
FIG. 1. LOCATING TOE OF WALL FROM OFFSET LINE



FIGS. 2 AND 3. CURVED RETAINING-WALL WORK ON A ROAD IN THE HUDSON HIGHLANDS

OFFSETS FOR SHORT-RADIUS CURVES, 10-FT. CHORDS

No. of Chords	R = 80 Ft.		R = 85 Ft.		R = 90 Ft.		R = 95 Ft.		R = 100 Ft.		R = 105 Ft.		R = 110 Ft.		R = 120 Ft.		R = 130 Ft.		R = 140 Ft.		R = 150 Ft.	
	at	tc	at	tc	at	tc	at	tc	at	tc	at	tc	at	tc	at	tc	at	tc	at	tc	at	tc
1	9.98	0.63	9.98	0.59	9.98	0.56	9.99	0.53	9.99	0.50	9.99	0.48	9.99	0.45	9.99	0.42	9.99	0.38	9.99	0.36	9.99	0.33
2	19.80	2.49	19.83	2.34	19.85	2.22	19.86	2.10	19.88	1.99	19.89	1.90	19.90	1.81	19.91	1.66	19.23	1.54	19.94	1.43	19.95	1.33
3	29.32	5.57	29.40	5.24	29.46	4.96	29.52	4.70	29.56	4.47	29.60	4.26	29.64	4.07	29.70	3.73	29.74	3.45	29.78	3.20	29.81	2.99
4	38.38	9.81	38.56	9.25	38.71	8.75	38.85	8.30	38.96	7.90	39.05	7.53	39.14	7.20	39.27	6.61	39.38	6.11	39.47	5.68	39.54	5.30
5	46.83	15.14	47.19	14.30	47.49	13.55	47.74	12.87	47.96	12.25	48.15	11.69	48.31	11.18	48.58	10.27	48.79	9.50	48.95	8.84	49.09	8.26
6	54.56	21.49	55.17	20.33	55.68	19.29	56.11	18.34	56.49	17.48	56.81	16.69	57.09	15.97	57.55	14.70	57.91	13.61	58.19	12.67	58.43	11.84
7	61.43	28.76	62.38	27.26	63.18	25.90	63.86	24.67	64.45	23.53	64.95	22.50	65.39	21.54	66.11	19.86	66.68	18.40	67.13	17.15	67.50	16.04
8	67.35	36.82	68.73	34.99	69.90	33.30	70.91	31.77	71.76	30.35	72.50	29.05	73.15	27.85	74.22	25.71	75.06	23.86	75.73	22.25	76.28	20.84
9	72.21	45.56	74.13	43.40	75.76	41.41	77.16	39.57	78.36	37.86	79.40	36.29	80.31	34.83	81.81	32.22	83.00	29.95	83.94	27.96	84.72	26.21
10	75.94	54.84	78.50	52.40	80.68	50.11	82.56	47.99	84.18	46.00	85.58	44.16	86.81	42.43	88.84	39.34	90.44	36.62	91.73	34.23	92.78	32.12
11	78.49	64.51	81.78	61.84	84.61	59.31	87.05	56.93	89.15	54.67	90.98	52.57	92.59	50.59	95.24	47.01	97.35	43.85	99.04	41.05	100.42	38.57
12	.....	.....	.....	.....	87.50	68.88	90.57	66.29	93.23	63.80	95.55	61.47	97.60	59.25	100.99	55.20	103.69	51.58	105.85	48.37	107.63	45.81
13	.....	.....	.....	.....	89.30	78.72	93.08	75.96	96.38	73.29	99.26	70.75	101.81	68.32	106.04	63.83	109.41	59.79	112.12	56.16	114.35	52.91
14	.....	.....	.....	.....	.....	.....	94.57	85.85	98.57	83.05	102.06	80.35	105.17	77.74	110.34	72.86	114.48	68.40	117.82	64.38	120.57	60.74
15	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	107.67	87.42	113.89	82.21	118.88	77.39	122.92	72.98	126.25	68.97



are best laid out by means of offsets. One important advantage of the method in such rough country as shown in the views is that no transit is required.

The retaining walls shown—on the Nyack-Rockland Lake road now under construction by New York State—were laid out quickly and easily by measurements from an offset line carried along near the toe. The method is indicated in Fig. 1. The fieldbook procedure is to compute elevations of top of wall at the required stations and the distances AT (Fig. 1) from toe of wall to vertical line through top of wall, for the height of wall likely to be required. As soon as the trench has been carried to proper foundation stratum, the elevation of the bottom of trench is found by level, and the height of wall is obtained by subtracting from elevation of top of wall. The distance AT is then read from the table of these distances in the fieldbook, and the distance TL, giving location of toe from offset line, can be computed. This gives the necessary data for erecting the batter boards with the required slope.

To get the initial distance AL on curved alignment, a table of tangent distances and offsets will be found useful. The table given herewith covers the principal range of radii used in sharply curving road alignment.

Safety Device on Hoists Used on Foundation Wells

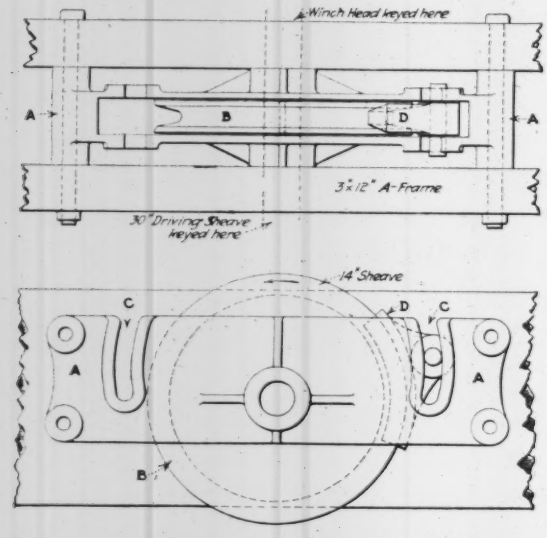
A safety device or grip for the hoists used extensively in Chicago for sinking foundation shafts or wells is shown in the accompanying illustration. The hoist consists of an A-frame or tripod with cross-timbers carrying a shaft that has at one end a winch head for the bucket rope and at the other end a 30-in. grooved sheave for the wire driving cable. This latter is an endless cable and serves a number of hoists in series. Should the cable break or leave the sheave, a bucket might overhaul or reverse the hoist and drop upon the men in the shaft. The safety device prevents this reverse movement.

Between the timbers of the headframe is bolted a casting A, which takes the place of the usual separator blocks; and within this runs a 14-in. grooved sheave or brake wheel B, which is keyed to the shaft. The casting has curved slots C, which are eccentric to the shaft. In these rest the ends of a short shaft carrying a grip or brake shoe D, which engages the groove of the sheave. When the sheave is running in its normal direction, as shown by the arrow, it tends to raise the shoe and thus keep it away from the groove, with very little friction.

If the driving cable breaks or comes off the 30-in. wheel and the bucket in the well starts to fall by overhauling the hoist, the friction from the reversed brake

sheave *B* forces the shoe downward. Its eccentric movement then causes it to jam this sheave so that the hoist shaft cannot revolve. Tests made with the device have shown that a 1-in. drop of the bucket is sufficient to apply the grip and prevent further movement.

Should the hoisting grip be so placed that the motion is in the reverse direction from that shown by the arrow,



AUTOMATIC SAFETY DEVICE FOR FOUNDATION HOISTS

the shoe would be lifted out of its seat and fitted to the similar curved slots at the other end of the casting. The device is made by French & Allen, manufacturers of contractors' equipment, 506 South Canal St., Chicago.

State Engineer's Office in Senate Chamber

The State Engineer of Arizona probably has the most "classy" drafting room to be found in the public service. A soft green plush carpet to tread upon and oil paintings to delight the eye are a few of the auxiliaries. This room, shown in the accompanying illustration, is the august senate chamber of the Arizona legislature in the state capitol at Phœnix.

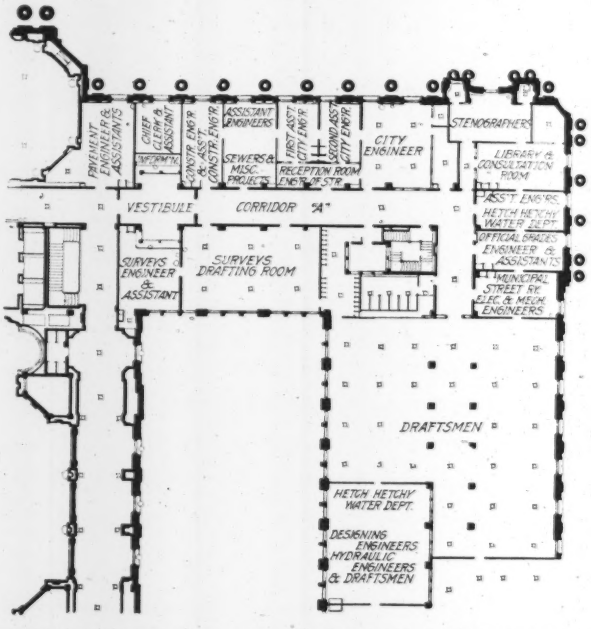
"DRAFTING ROOM" OF THE STATE ENGINEER OF ARIZONA

Fortunately, the legislature meets only biennially, so the room has to be vacated by the state's useful employees only occasionally. The state engineer's office proper is a modest room adjoining the senate chamber, but his private office between sessions is the office of the president of the senate at the right-hand side of the rostrum. The State Engineer is Lamar Cobb.

City Engineer's Offices, San Francisco

The city engineer's offices of San Francisco, now presided over by M. M. O'Shaughnessy, are arranged as shown by the accompanying plan. Like the other offices in the new city hall, these are equipped with the most recent type of devices for convenience and efficiency.

Approaching the department along corridor A, the visitor first passes through an outer door into a large public vestibule. At one side is the information counter,



ARRANGEMENT OF CITY ENGINEER'S OFFICES, NEW CITY HALL, SAN FRANCISCO, CALIF.

served by a chief clerk and assistant; on the other the survey counter, where the engineer of surveys and his assistants transact their business with the public. The pavement engineer and his assistants are accessible at the information counter, so that a large volume of business can be disposed of without admitting the public past the entrance vestibule. Beyond is the corridor leading to the offices of the various department heads and the city engineer. No one is allowed to enter this corridor or the offices adjacent to it except by direction of the chief clerk or his assistant.

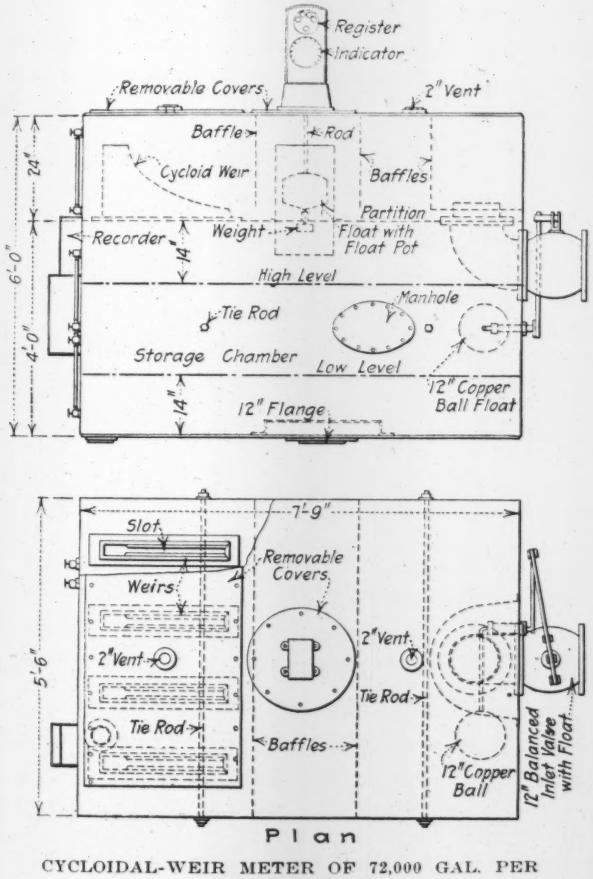
A dictograph system provides for direct intercommunication between all offices of the department. The offices of the city engineer, first and second assistants are furnished with master dictograph stations connected with all offices and drafting rooms of the engineering department and also with the mayor, city attorney, commissioners of public works, accounting department and cashier.

Cycloidal-Weir Water Meter in Power Plant

For measuring the water used at the power plant of the Minneapolis General Electric Co., at Minneapolis, Minn., a Kennicott cycloidal-weir meter has been installed, having a capacity of 1,200 gal. (or 10,000 lb.) per min. The device consists of a steel tank divided into two parts by a horizontal partition. The water is delivered to the upper compartment, which has baffle plates to check eddying, and a float to operate the register and indicator.

Upon the partition are four weirs, which are narrow upright boxes, having one side shaped to a cycloidal curve and with the slot or orifice in the curved face. With this arrangement the flow of water through the weir is directly proportional to the head above the weir at any stage of water level in the compartment. The meter is reported to register the weight of water within 1½% of the exact flow; this presumes the meter to be adjusted to the actual water temperature.

The water passing through the curved weir slots falls into the lower or storage compartment. An indicator



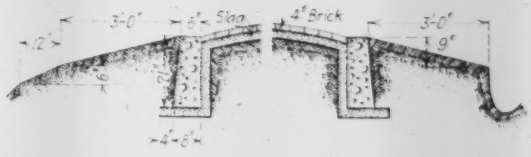
CYCLOIDAL-WEIR METER OF 72,000 GAL. PER HR. CAPACITY

shows the rate of flow, and a register shows the total amount of water that has passed through the meter. A recording gage or chart may also be applied. This water measuring device was built by the Kennicott Co., Chicago Heights, Ill., which owns the patents on the cycloidal weir. H. M. Byllesby & Co., Chicago, are consulting engineers for the power plant.

Slag Base for Brick Roads in Pennsylvania

Brick roads in Westmoreland County, Penn., are built as shown in the sketch. Prior to May 11 either stone or slag was specified for the base, but since that date slag alone is called for. The slag is obtained both from the Carnegie Steel plant and from the railroad.

On the slag base rolled to a thickness of 6 in., an inch of sand is placed. On this are laid the bricks, which



CROSS-SECTION OF TYPICAL BRICK ROAD (SLAG BASE) BUILT IN WESTMORELAND COUNTY, PENN.

are bought from kilns in the general vicinity. At the present time five sections of roads are under contract, aggregating 8.25 mi.

Greensburg—the county seat of Westmoreland—also is building some brick roads of this familiar construction. Before rolling, the slag is 12 in. thick; afterward 6 in. A sand cushion 2 in. thick is specified, but rarely attained in practice, the object being merely to even the slag bed. Last season Greensburg paid $1.34 per sq.yd. (exclusive of excavation) and $0.44 for the excavation, which is done by hand.

NOTES

A Handy Tool For Blasters has been invented but not patented by Carl D. Livingston of the College of Agriculture of the University of Wisconsin. It is a combination fuse cutter, cap crimper and fuse slitter all in one. Many serious accidents have happened from rough or flattened fuse ends, which make it necessary to twist the fuse into the cap with more or less force. A clean cut, square cap end is always desirable, because the cap will not stand careless treatment without danger of exploding. The new tool is shaped like a pair of pruning shears and has an adjustable blade which can be sharpened. Firm, smooth, and tight connections between fuse and cap are obtained by means of a special crimping device, placed directly under the pin. The slitting device is on the end of the cutting blade.—"Wisconsin News Bulletin."

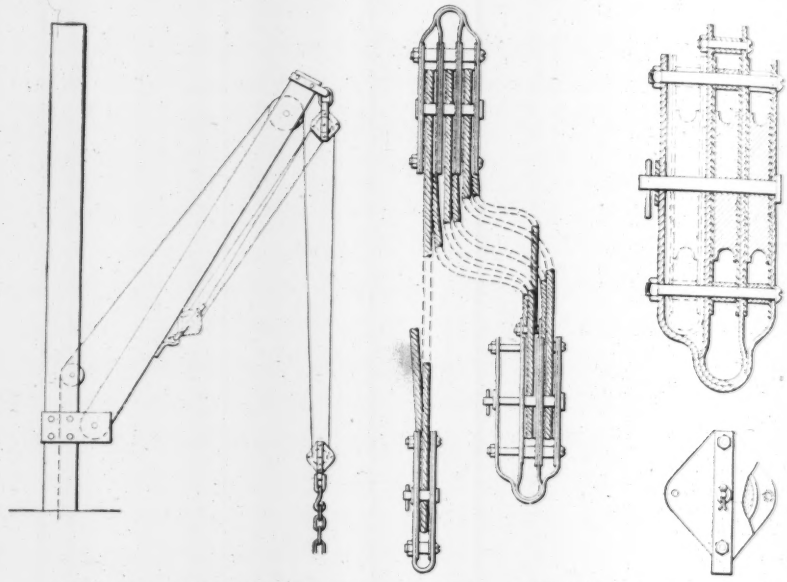
Protecting Auburn's Water-Supply—In making daily inspections, during the year 1915, to protect the purity of the water-supply of Auburn, N. Y., drawn from Lake Owasco, the inspectors of the Auburn Water Department traveled 4,070 mi. by train, 2,500 mi. by motorcycle, 500 mi. by horse and wagon, 317 mi. by automobile and 54 mi. by boat, besides walking 2,633 mi.—which doubtless seemed more than all the rest put together. By means of this total of over 10,000 mi. of travel 27,535 inspections were made, 470 written notices for violation of rules and regulations were served, and several thousand copies of the water-supply rules were distributed to campers and owners along the lake shores. All this work was done in accordance with the provisions of rules and regulations for the State Department of Health to protect the water-supply of the City of Auburn, in accordance with Sec. 71 of the Public Health Law of New York. To keep tab on the character of the water coming down from Lake Owasco for the city, 637 bacteriological examinations were made. Gas-producing bacteria were found in 88 of the samples. The water was treated with liquid chlorine for a total of 195 days during the year. For a greater part of the time the bacterial count determines whether or not chlorine shall be used, but during portions of the year chlorine is used regardless of the count. J. Walter Ackerman is engineer and superintendent of the Auburn water-works.

Cargo Weighed Graphically—The displacement method of determining the weight of cargoes of stone is described as follows by A. S. Ackerman in the May "Journal" of the Boston Society of Civil Engineers:

The draft marks of a vessel are taken at the stem and stern loaded and again when lightened and pumped out. In the latter condition the vessel is measured, an operation which occupies about an hour, after men have become accustomed to taking measurements. The length is taken horizontally on deck, forward of the after part of the stern post, which is called station zero, to a point just forward of the loaded mark on the cutwater, the length being divided into stations of 10 ft., and at the bow, sometimes, of 5 ft. At these stations the semi-widths are obtained to the outer edge of the rail, and then at each succeeding station offsets from a plumb line hung from the rail by means of an outrigged stick so that the line just touches the side of the hull at the widest part of the section, are taken to the side of the hull at each even foot above light water-line, the plumb line being tagged every foot. These measurements are taken as carefully as possible horizontally and normal to the axis of the vessel; and the distance subtracted from the semi-width at the rail plus the distance to the plumb line from the outer ends of the rail gives the semi-width of the vessel at each even foot plane above light water-line for each station. After measurements are taken at all stations, the slant of the cutwater and sternpost is obtained in the same manner. Each station section taken as above is blotted on cross-section paper and a mold of the hull at that station for the distance displaced. From these sections distances are taken and a horizontal section of the hull plotted for each foot above light water-line. These areas are then planimetered and the volume for each foot computed and plotted as a curve. In determining the cargo carried by a vessel, the mean of the bow and stern displacements is read off the curve, giving the tons directly. In computing the weight, that of sea water is assumed as 64.2 lb. per cu.ft., and tons are obtained in units of 2,000 lb.

Well Points and Triplex Pumps Drain Quicksand—The accompanying illustrations show in use part of an installation of one hundred 1½x36-in. No. 60 well points used by James Ferry & Sons, of Atlantic City, for unwatering a sewer trench that ran through a bed of quicksand. On previous jobs in this locality the trench has caved and sand has flowed even from back to the curb and sidewalk. The normal water level is between 2 and 3 ft. below the surface, but by working the pumps only continuously it is held down to 12 to 15 ft. below. Two complete outfits have been provided, each comprising 100 well points, 100 six-foot lengths of rubber hose, 100 valved T-connections, about 600 ft. of suction main and a 7x8-in. Goulds triplex pump (5-in. suction and discharge) belted to a 7½-hp. electric motor and having a capacity of 250 gal. per min. Motor and pump were set up in a portable shed.

Reducing the Parts of a Hoisting Line to two without extensive change of tackle is the purpose of an invention just announced by C. M. Seacombe, 259 West 34th St., New York City. The sketches explain the scheme. It is of service on jobs where there are light pieces to be hoisted, as well as heavy, or for assorting and setting steel (using 2-part line) after it has been hoisted by a 4- or 6-part line. A very similar device was employed by the American Bridge Co. in erecting the Hell Gate arch for the New York Connecting R.R.



HOW TO MAKE A MONKEY PURCHASE (TWO PARTS) OUT OF A MANY-PART HOISTING LINE IN A FEW MINUTES

Gravel Ballast under the old specifications of the American Railway Engineering Association is allowed 30 to 35% of sand, but the Ballast Committee considers that further specifications should be made as to the proportions of material of different sizes. Tests of actual ballast on different railways showed proportions (by weight) of wide variation, as follows: Passing ⅛-in. screen, 0.6 to 43.4%; retained on ⅛-in., 2.4 to 48.6%; retained on ¼-in., 15 to 37.6%; retained on ½-in., 12 to 64%; retained on 1 in., 4.3 to 13.2%. The committee has pointed out that the efficiency of gravel for ballast is much improved by washing.

WELL POINTS AND TRIPLEX PUMPS USED TO DRAIN ATLANTIC CITY QUICKSAND

Editorials

Long-Term Water-Works Bonds

The experience of water-works engineers with longer-lived equipment than found in most other public utilities evidently inclines their minds toward longer-term bonds than are now customary in financing water-works projects. The thoughtful article by Mr. Butcher, printed elsewhere in this issue, is only one of the multiplying evidences of this feeling. It is possible that the accumulated experience of water-works may warrant some extension of present bond terms, but such a move should be very cautiously made and with due regard for the "public policy" which conscientious officials use as the excuse for shortening terms.

One reason for maintaining no longer bond terms than now prevailing, prominent just now but not discussed by Mr. Butcher, is the risk of obsolescence. It avails nothing if the apparatus be physically long lived, if it becomes inadequate, antiquated or uneconomical. There are numerous cases where cast-iron mains still good for long years of service have been discarded because of the need for larger pipe or different sources of supply. In other instances old reciprocating pumps, in good repair and running at nearly original duty, have been replaced by high-speed centrifugals.

We do not know the conditions under which the next generation of engineers and financiers must work, and therefore we should endeavor so far as possible to preserve for them a balance of liabilities equal only to the unimpaired physical assets. Lengthening the term of bonds tends away from that end and is not to be done without the most careful deliberation.

After all, it is barely possible that undue worry is caused over this quick redemption of bonds. If the bonds are paid off, the public as a whole cannot have that amount of principal in private service and paying private dividends; but if the bonds are not paid, roughly the same sacrifice is required—since the public pays the interest on the bonds. All in all, then, a cautious public policy is a proper ideal.

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Popularizing Water Meters

That there is a deep-seated prejudice against water meters in the popular mind every water-works superintendent knows only too well. An important part of his job is to dispel the prejudice by substituting information for ignorance. That done, he has gone more than half way in converting wholesale opposition to meters into a general demand. He cannot expect to jump that far at one leap. Instead, he may have to be thankful if he makes an occasional convert to the use of meters. To keep doing this water-works officials must conduct a never-ceasing campaign of education and interest.

There are various ways of creating a popular demand for meters. The thing of fundamental importance is to establish meter rates and rules that will be their own argument for selling water by meter instead of by guess.

With this as a solid foundation a campaign of publicity is imperative. There are various ways of conducting such a campaign. One that has been tried effectively to further the use of water as well as of water meters is use of the advertising pages of the local press. Efforts of this kind best known among the water-works fraternity are probably those conducted for some years past at Terre Haute, Ind., and noted more than once in the columns of *Engineering News*. Elsewhere in this issue there are reproduced a number of advertisements of water and water meters that have been run in the local papers at San Antonio, Tex.

It is significant that the water-works at both Terre Haute and San Antonio are owned by private companies. How many other companies push the sale of water and the demand for water meters by advertising is unknown. Some, doubtless, but comparatively few, it seems. Probably very few do it so effectively as the two companies mentioned.

Would it be against good public policy for municipally owned works to advertise in like manner? Whatever the answer, probably it could rarely be done without going to the legislature for authority. Lacking authority, or deeming it not good policy for a municipality to promote the sale of water or the use of meters by advertising, other effective, if not equally effective, ways of popularizing water meters could doubtless be found by wideawake municipal water-works officials. Where there's a will there's a way! Who will lead? Who is already in the lead, but too modest heretofore to make it known?

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Firestopping as a Safeguard for the Wooden House

There is something new under the sun occasionally. A modest book of a hundred pages or so, just issued, belongs in the distinguished class of new things. Addressing itself to every homebuilder, it tells him, to his great advantage, certain vital matters that he could not learn before this. It gives him advice on how to make his wooden house safe by firestopping.

Firestopping is by this book developed comprehensively into an art, or a science. In fact the art is newly created. Rudiments of it have existed, but even in this form it was nowhere recorded. Gathering together the elements of present practice, and rounding them out into a complete art by study and redesigning on the basis of modern fire-protection science, the authors of the book have created something radically new.

It is true, firestopping is only one of ten or eleven chapters in the book. It is also true that the book has much to say on houses with masonry walls, houses with concrete floors or incombustible partitions and other rare features. But the vital portion is that which bears in a practical way on the thousands and thousands of dwelling-houses built every day—the wooden houses—and shows how a little care, and perhaps a very few dollars added, will make them vastly safer against fire ruin.

Two chapters besides the one mentioned have the same extensive interest and value; in fact they belong under the same head of firestopping. They deal with the roof and the cellar, and their aim is to show how the main body of the house may be cut off from the hazards above and the hazards below. The cellar ceiling and the roof and eave structures, being the lower and upper terminals of the firestopping system, are integral parts of that system.

The National Board of Fire Underwriters, whose engineers and fire experts wrote the book, publishes it under the title "Dwelling Houses; a Code of Suggestions for Construction and Fire Protection," and plans to distribute it free. For the price of mailing, ten cents, a copy will be sent to whoever asks for it. More copies may be had, for the cost of the express charges. Such openhanded gratuitous distribution represents a gift to the public that is remarkable in its importance. It is greatly to be hoped that the public will respond in a proportionate degree, by studying and using the treatise.

If we mistake not, Ira H. Woolson pulled the laboring oar in the preparation of the book, and correspondingly deserves chief credit for the new technical achievement. But whoever may be responsible for the work, congratulations are due on the successful result. The book marks an epoch in building practice.

Government and Student Free Engineering Service

Kentucky is the latest center of agitation over free engineering service in alleged unfair competition with engineers who, however much they would like to serve the public without charge, are yet forced to depend upon fees for a living. A letter published elsewhere in this issue raises questions regarding the action of the United States Public Health Service in responding to a request from the City of Lexington, Ky., for advice regarding the advisability of going into a scheme for treating sewage by an electrolytic method, the city already having in hand a report by a firm of consulting engineers recommending an entirely different scheme of sewage disposal.

A second letter, also published elsewhere in this issue, calls attention to a notice which appears to have been published generally in the city press of Kentucky offering the services of senior engineering students in the University of Kentucky for the preparation of plans and specifications for water-supply and sewerage systems, the work to be done under the direction of the Dean of the Civil Engineering Department.

On first thought it will very likely seem to the majority of practicing engineers that in each case the rendering of gratuitous service in the way specified is an unpardonable injustice to members of the engineering profession. The matter, however, is not quite so clear and simple as appears on the surface, especially as regards the advice sought of and given by the United States Public Health Service.

Taking up that case first, the well put statement of the Public Health Service side of the case made by Surgeon-General Rupert Blue should be considered. The gist of this is that the Service prepares no plans and has nothing to do with construction. It may be explained further, a fact not brought out in the correspondence and only hinted at in the opening paragraph of this note, that substantially all that the Public Health Service investigation and report covered was whether the report and plans already before the City Council when promoters of a proprietary scheme appeared upon the scene were well suited to solve the Lexington sewage-disposal problem. If it be asserted that even this was a matter which should have been left for some consulting engineer in regular practice to settle, then it may be replied that city councils have not yet reached such a state of perfection and have not yet attained such confidence in consulting engineers serving for pay as to make these officials always feel that they can satisfy their own consciences and perchance the clamors of the public by relying implicitly upon paid engineers. The city authorities of Lexington doubtless considered, and considered rightly, that they could get disinterested advice from the United States Public Health Service.

After all that has been said, however, there still does remain a basis for questioning whether the United States Public Health Service is justified in undertaking to respond to such a call as came from Lexington, even though it had, as Surgeon-General Blue says, been some time engaged in studying water-supply and sewage disposal at Lexington in connection with a general investigation of stream pollution. The question is a part of the far larger one as to the proper delimitation of the functions of Federal, state and local authorities, in health and in other matters.

Coming now to the question of the free engineering services by students from the University of Kentucky there may first be considered the argument for the offer evidently conceived by many higher institutions of learning. This argument, as it runs in the minds of many, is that a university supported by the state owes a duty to the state and its various divisions which goes beyond that merely of giving instruction. The argument runs, further, that many of the communities of the state, at least the smaller and more backward ones, would go for years without proper engineering or other technical or professional advice before they would sufficiently recognize its worth to bring in and pay for the services of an engineer or other professional man. Some of these places, however, will accept an offer from a state university or engineering or other school supported by state funds (and perhaps they would not stick at whether the financial support was public or private) to have a preliminary investigation and more or less complete plans and estimates made for public improvements. Such plans and estimates having been made, and for that matter in the very making arouse public attention to the advantages and finally convince the citizens of the necessity of the improvement. Meanwhile, it is urged, students have been getting the benefit of practical experience that they could not otherwise obtain while in school.

A far more serious question than the effect on the profession is the character of the service likely to be rendered under conditions of either free Federal aid or free assistance by engineering students. In saying this, we are not questioning the advice given by the United States Public Health Service in the particular case in hand. As a general proposition, however, the various branches of the Federal government are not sufficiently well manned either in numbers or professional competence of the majority of such staff as exists to

make proper studies of local questions, determine all the various facts based upon local conditions, and then give advice—much less prepare plans and specifications—that will meet the needs of the case.

The chances of getting proper service from engineering students are of course slimmer than for getting it from Federal bureaus. Of course the only hope for reliable work in the case of students is the direction that can be given them by their engineering professors or instructors. It might be argued that when the students reach the close of their senior year they are as competent to go out and work under the direction of a professor as they would be to step into an engineering office or field party and work under the direction of an engineer or private contractor. To a large extent this is true, but to how large an extent?

The whole matter is many sided, beset with difficulties, and probably will not be settled definitely for some time to come. Meanwhile it is well to remember that it is not merely a bread-and-butter affair, but one involving service to the public by Federal and state governments and institutions supported by public funds.

Centralized Municipal Shops

The fine new central repair-shop and storage-warehouse plant of the City of Chicago, described elsewhere in this issue, calls attention to a notable development which is growing in importance all over the country. New York City has just established a Department of Plant and Structures to replace the Department of Bridges and to operate consolidated repair shops for all boroughs and all departments (as noted in *Engineering News*, Apr. 13, 1916). This will save a million dollars a year. On the Pacific Coast, San Diego has such a central shop, and Los Angeles seems to be approaching it with its water-works repair plant.

This commendable movement is only a logical development of municipal government previously paralleled in the history of most public utilities and many industrial concerns. It is one of the economies and refinements that comes as a city approaches its final status and overcomes the handicaps of pioneer days which make any maintenance of adequate fire, police, water and sewer services difficult, to say nothing of economical.

Forests and Rainfall Again

Dr. Nicholas Murray Butler, President of Columbia University, before the recent annual meeting of Associated Press representatives in New York, made an eloquent appeal for national unity, which deserves and has received wide attention and commendation. There is one passage in Doctor Butler's fine address that deserves a word of comment in these columns. We quote as follows:

> **We must remember that the greatest empires have fallen as well as risen. There is no reason to suppose that our America is going to escape the everlasting law of change. Who can predict how many hundreds or thousands of years it will take before the forests will be felled, and the streams will be dried, and this great fertile continent of ours, like the plains of ancient Iran, where civilization began, will become a desert fit only for surveying parties of the archæologists?**

The theory that rainfall and stream flow are dependent upon the existence of forests and that it is the removal of the forests which has caused parts of Asia Minor and China to become arid deserts, was given wide publicity by the Government Forest Service some ten years ago. Notwithstanding the repeated demonstrations by engineers of the fallacy of this theory, evidence recurs every little while of the extent to which the theory has taken hold of popular imagination. The prominence given to this theory in President Butler's notable address makes it worth while again to call attention to its fallacy. Some of the other causes well set forth in the speech may conceivably reduce the United States to desolation, but he can be assured that no matter how much the forests may be depleted during hundreds or thousands of years, their removal will not make this fertile continent a desert.

More Facts About Concrete

Because design requirements dictate the fixing of unit stresses in concrete more or less unrelated to conditions of manufacture, there has arisen a tendency to regard such artificial standards as immutable and to assume that a concrete which varies considerably from the set average is peculiar and abnormal. Those concerned with the testing of materials, however, are not so chained to the average as is the designer and they are not so apt to consider the nature of concrete an open book. This is fortunate for the designer, because the scientific curiosity of the tester is constantly revealing new facts and upsetting old theories.

While possibly no very radical discoveries nor startling upsets can be found in the latest concrete report of the United States Bureau of Standards, noted on another page, it is a fact that that report contains more complete and succinct information on the compressive strength of concrete than has ever been gathered together in one volume. It is, in stock phrase, a veritable mine of facts. Many of the current controversies may be settled by reference to its pages, many faults in practice might be cured by following its lessons. The space at the command of a periodical does not permit more extended reference to the tests than is given elsewhere, but we can heartily commend its study to all concrete practitioners.

Twenty-Eight Millions of Work for One Contractor

The fascination of large contract figures is supplemented, in the case of a remarkable record made during the week just past, by the separate fascination of the difficult nature of the work. Securing a paltry 2½ million dollar contract last Thursday, the Flinn-O'Rourke Co. piled up the prodigious total of $28,000,000 worth of tunnel and subway contracts in New York City. The chief item in the list is a group of six subaqueous tunnels—three sets of two each. These are all under the East River, and they possess every bit of the difficulty and danger that everywhere characterize tunnel-driving in loose river bottoms.

In this large program of work that the above figures represent a dozen tunneling shields have already been starting and are pushing forward, most of them with the help of compressed air. Eight more are to be erected soon, to drive the pair of tunnels at Fourteenth St.

There has been no prior case of 20 shields working simultaneously under one contractor's direction and on the same enterprise.

Letters to the Editor

Panama Canal an Unprofitable Business Enterprise

Sir—Six years ago, in your issue of Feb. 10, 1910, you were kind enough to print a letter from me criticizing the economic aspect of the Panama Canal undertaking. In the editorial comment appended to that letter, the military rather than the commercial advantages of the canal were emphasized. Since then the canal has been actually completed and opened to traffic, and the greatest war of history has come on and still rages. Actual war has shown how slight is the advantage of a few warships more or less and how serious is the economic strain of a great war under modern conditions.

To return to the writer's protest against unsound economic action by this nation, it is unfortunately the case that the nation's expenditure on the Panama Canal is taken as a precedent and a yardstick by which to justify other proposed national expenditures, as for instance national highways, drainage projects, waterway improvements, ship subsidies, ship construction, etc. The canal passed 6½ million tons of shipping in the first year of its operation (Prof. Emory R. Johnson predicted it would have 10½ million tons that year). For months and months of its second year it was blocked by the slides; and now, according to the testimony before the Interstate Commerce Commission on Apr. 24, the managers of the principal steamship lines which ply from coast to coast say they will not resume traffic by this route for one to two years, and possibly longer. Meanwhile interest on the nearly $400,000,000 that the canal has cost goes steadily on.

In conclusion, my argument as to what can be justifiably spent now for future benefits, as contained in my article of February, 1910, and based on A. M. Wellington's line of reasoning, has lost none of its force from what has since come to pass. A. P. C.

Nashville, Tenn., May 4, 1916.

Cost of Utility Changes Made To Avoid Interferences

Sir—The article on "Cost of Utility Changes Made To Avoid Interferences," in *Engineering News*, Mar. 23, 1916, gives no reason why the method advocated is theoretically correct. The matters discussed are becoming daily of greater importance, so that the writer has judged a further attempt to elucidate the proper theory to be of interest and service to utility engineers.

Any attempt to analyze the question of charges in such cases must involve a large number of assumptions. The influence of many of these assumptions on the final cost will, however, be so small that they may be neglected or considered to balance one another. For the sake of clearness the corporation in prior occupancy of the street will hereafter be spoken of as the company, and the person or corporation desiring to have the changes made will be referred to as the contractor.

Clearly, the company is entitled to demand that the work shall be done at no cost to it and that its property on completion of the work shall be of the same value for its purposes that it was before the changes. The value to any public-service corporation of any portion of its plant at any time may be divided into the revenue-producing value, present and prospective, and the present worth of the recovery value at the end of its useful life. The revenue-producing value may be thought of as a capitalization of the revenue earned by the plant unit in question. This revenue will ordinarily be sufficient to cover all annual and maintenance charges on the unit, including the amortization, within the useful life of the unit, of the difference between the cost of installation and the recovery value. The recovery value may be defined as the difference between the cost of removal and the value of the recovered unit for re-use or as junk. In the case of plant that cannot be abandoned when no longer useful this recovery value may be either a liability or an asset.

The present worth of this future recovery value is the sum which, if invested or borrowed (as the case may be) at the present time, would at the end of the useful life of the unit amount to its recovery value.

All jobs involving the replacement of existing plant units with new units result in a theoretical benefit due to the increased life and a theoretical detriment due to working on existing plant. Since both of these are vague quantities and may never be realized in actual practice, it will in most cases involve no appreciable error to assume that they balance each other and therefore to neglect them. If the work is done by the company, the cost of financing the changes until the bill is rendered and paid should, if considered at all, be added to the bill as a certain percentage or as a fixed sum and should not be confused with the material and labor costs of doing the work.

In each of the cases considered, except that in which a unit is replaced with one of larger capacity, it is assumed that the revenue-producing values of the old and new units are the same. This may be made clear for the case of a unit replaced with one of smaller capacity by a consideration of the following example: A factory, surrounded by homes of the employees, in an outlying section is burned and is not to be rebuilt. Most of the houses are therefore abandoned. The value to the company of the plant installed to care for this locality is then its greatly reduced revenue-producing value plus the present worth of its recovery value at the end of its useful life. Plant of smaller capacity would evidently have the same revenue-producing value.

In all cases in which the revenue-producing value remains the same the value to the company of the plant removed should be compensated for by the contractor as follows: The revenue-producing value by the installation of new plant of an equal revenue-producing value; the present worth of the future recovery value by (1) the equal present worth of the future recovery value of

the new plant installed or (2) the present worth of the future recovery value of the new plant, together with a cash adjustment of the difference between this amount and what would have been the present worth of the future recovery value of the old plant if no changes had been made. The company is thus fully compensated for the value of all plant removed and can have no claim on the material recovered in connection with the work.

When a unit is replaced with a unit of larger capacity, the contractor should pay the cost of replacement with a unit of equal capacity; and all material recovered should be credited to the contractor. The company thus receives equal revenue-producing value and present worth of future recovery value at the contractor's expense. The company secures at its own expense the additional revenue-producing value and present worth of future recovery value of the larger unit by paying the extra cost due to replacement with the larger unit. The rule for all cases is therefore as follows:

> Charge the contractor for all material, labor, supervision, etc., for the change. Credit the contractor with all material recovered. Charge the contractor an amount equal to the present worth of the future recovery value of the old plant if no change had been made. (This will be a credit if the recovery value is a liability.) Credit the contractor with an amount equal to the present worth of the future recovery value of the new plant. (This will be a charge if the recovery value is a liability.) When the new unit is of larger capacity than the old, these rules apply to amounts not exceeding the charges and credits for a unit of the same capacity, since that is the extent of the contractor's responsibility.

This differs from the rule given in the article under discussion in that the latter gives to the company the present value of the recovered unit for re-use or as junk, with no charge for removal, instead of the present worth of the future recovery value, which was defined as taking account of the cost of removal. The company would thus make a profit on the job, amounting to the cost of removal of the old unit plus the difference between its present recovery value and the present worth of its future recovery value. If a profit is to be made, it should not be confused with the accounting charges in this manner and probably should not be a function of the time the plant is to remain in service. DWIGHT F. NORTON.

227 Gates Ave., Brooklyn, N. Y., Apr. 4, 1916.

Effect of Stream Turbulence on Current Meters

Sir—It has for some years been known that measurements of flow in pipes, conduits, etc., determined by indications of the velocity head with pitot tubes or venturi tubes frequently gave over-registration when the rate of discharge was subject to great and frequent fluctuations. As far as the writer knows, no satisfactory explanation of these phenomena has been made. Apparently, rotary meters of the paddle-wheel type are subject to the same difficulty to a much greater extent, and the fundamental cause may be the same.

In the case of the measurement of a stream with a current meter a simple explanation may be that, where the velocity varies, the rotating parts of the meter will be subjected to different impulses in the same direction. Those greater than the average will impress upon the meter a velocity which it will retain until friction reduces it to the average velocity, so that the tendency must be for this reason to over-register. Obviously, the more mass in the rotating parts the greater will be its effect. The only remedy would seem to be to make the rotating parts of the meter as light as possible, say of aluminum.

The writer has every reason to believe that in a turbulent stream the measurement with a standard current meter might be from 15 to 50% high on this account, while if the same meter were rated in water of a constant velocity, it would show perfect accuracy. The effect is about the same as if a meter were given an initial velocity before being placed in the water, and while in that position every impulse greater than the average would have the same effect.

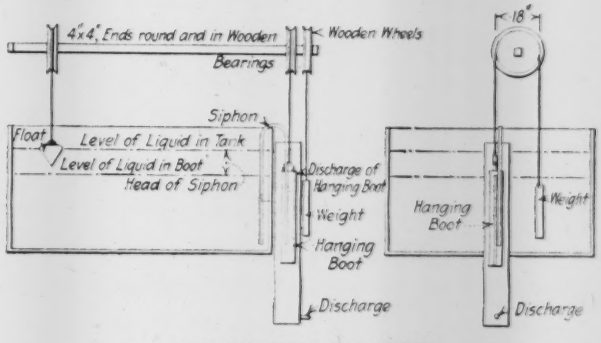
The matter is of great importance, because many of the rating tables prepared by the Government are based on current-meter measurements for streams whose flows are subject to large fluctuations. J. W. LEDOUX.

112 North Broad St., Philadelphia, May 6, 1916.

Constant-Flow Device

Sir—In *Engineering News*, Apr. 27, 1916, I note an article by Mr. Westen Gavett, describing a device to give constant flow of liquid. I inclose a sketch of the device used by me for some years to give constant flow of acid on our Glover and Gay Lussac towers.

It consists of a 4x4-in. timber, the ends turned round and mounted in wooden bearings above the supply tank. Spiked on this are three wooden wheels—each made of a circle of a 2-in. plank, with a 1-in. circle on each side, nailed with the grain at right angles to that of the 2-in., and forming a rim. From the first of these wheels



CONSTANT-FLOW SIPHON

hangs a float, resting in the liquid of the supply tank. From the second wheel hangs a boot by means of a chain threaded through the handle. In the end of the chain is a hook which fastens into a link of the chain, and enables the boot to be raised or lowered. This boot has a discharge near the top, and empties into a discharge box surrounding it, with its opening near the bottom. The third wheel carries a weight balancing the boot and float. A siphon is set with one leg in the liquid of the supply tank and the other in the hanging boot. The head of this siphon, and therefore its flow, is controlled by lowering or raising the hanging boot; and once set, the head and discharge remain constant, for float and boot rise and lower with liquid of the supply tank. For use with acid the tank is lined with lead.

A handy man can build and set up this device in a very short time and at a small expense.

ISAAC C. BREWER.

Civil Engineer; Superintendent Jarecki Chemical Co.

Sandusky, Ohio, May 3, 1916.

Federal Public Health Service as Consulting Engineers

Sir—Herewith is a report upon the sewage-disposal project of Lexington, Ky., made by the United States Public Health Service, acting apparently in the capacity of consulting engineers. If such gratuitous reports should be recognized as proper, then consulting engineers who have made a life study of sewage disposal and looked to such appointments for their livelihood must ultimately seek other occupations.

ALEXANDER POTTER.

50 Church St., New York City, Apr. 15, 1916.

[Mr. Potter's letter has been submitted to the United States Public Health Service. A reply, from Surgeon-General Blue, is appended. Some comment on the questions raised appears on the editorial pages of this issue.—Editor.]

Sir—I beg leave to acknowledge the receipt of your letter of the 17th instant, inclosing copy of a communication received by you from Alexander Potter, in which he questions the propriety of the Federal Government investigating and reporting on the sewage problems of municipalities.

In reply you are informed that on requests of states and municipalities investigations are undertaken from time to time to stimulate improved methods of sewage disposal in the interest of the public health. These studies do not involve the preparation of particular plans, however, nor the supervision of construction. Oftentimes failure to respond to requests to make such studies would operate to prevent indefinitely any improvements contemplated. The relation borne by the service to the authorities previously mentioned, therefore, is one of helpful coöperation and of advantage to the engineering profession generally.

In the particular instance referred to in your communication service officers had been studying sewage and water problems of Lexington for some time in connection with general investigations of pollution of streams, and the city authorities had also previously employed engineers to go over the local situation and advise them.

RUPERT BLUE,
Surgeon-General.

Bureau of Public Health Service, Washington, D. C., Apr. 19, 1916.

Student Engineers Offered to Kentucky Cities in May

Sir—Herewith is a clipping from the Lexington, Ky., *Leader* of Apr. 11, 1916, which is of interest in connection with the question of student employment in competition with practicing engineers.

While it may be true that the work Professor Rowe and his student engineers do would not seriously embarrass any practicing engineer, it does mean that the value of engineering service is minimized in the eyes of the public; and the profession is, to that extent, injured when advice is offered on "a something for nothing" basis.

In this particular instance Professor Rowe is freely offering "complete plans and specifications and estimates for water and sewers in such form that they may be used in part or entirety." After such a proposition from the dean of the civil-engineering department of the state university, it will doubtless be difficult to convince a city council to employ an engineer who charges real money for his services.

I am told that this notice has not only appeared in the Lexington papers, but has also been given some publicity throughout Kentucky.

G. R. SOLOMON.

Atlanta, Ga., Apr. 15, 1916.

[The clipping from Mr. Solomon reads as follows:

In an endeavor to coöperate in the movement to better the sanitary conditions of towns and cities of Kentucky, the College of Civil Engineering of the University of Kentucky will offer the services of its senior students during May to complete plans, specifications and estimates of building proper sewage and water-supply systems of the cities in such form that they may be used in part or carried out in entirety whenever the municipal authorities order it to be done. The students will spend a month in the field, taking field notes and accumulating the data needed for the drafts and plans. The work is under the supervision of Prof. Walter E. Rowe, dean of the civil-engineering department of the university. Professor Rowe will visit the scenes of activity of the young engineers and give instruction and outline the work to be done.

Comment on this subject may be found on the editorial pages of this issue.—Editor.]

Turneaure's Impact Formula Too Complex

Sir—The impact formula given on p. 286 of your issue of Mar. 30,

$$K = \frac{1}{1 + \frac{L^2}{30{,}000}}$$

if adopted universally might serve as an unfortunate example of the use of empiric data.

The Rankine column formula has been largely abandoned in favor of straight-line formulas because its increased accuracy is not worth the extra labor of using it mentally, and looking up values in tables is annoying. Type of floor and ratio of dead- and live-load stresses affect impact as well as loaded length, and an impact formula which considers only one factor should be so simple that it can be applied mentally.

The values of $K = 100 - \frac{1}{4} L$, with minimum of 15, can be computed at sight without using the slide-rule. Comparing with the other:

Span, ft.	0	25	50	75	100	150	200	300	400	500	600
First formula...	100	98	92	84	75	57	43	25	16	11	8
100 — ¼ L.....	100	94	88	81	75	62	50	25	15	15	15

For the chord members of a 200-ft. span having a live-load stress of 100, the dead-load stress might reach 50 and the total stress by the two formulas would be 193 and 200 respectively. The difference is 3½%. For a 600-ft. span the percentage of difference would be less. The errors in the usual methods of design for ordinary cases are considerably larger than 3½%.

The writer of course does not presume to criticize Prof. Turneaure's work, nor is he competent to propose new impact formulas. He simply wishes to point out that often very simple expressions may be found to represent the results of complicated observations with an accuracy quite sufficient for all practical purposes.

C. T. BRADY, JR.

544 Bartolomé Mitre, Buenos Aires, Argentina, Apr. 26, 1916.

North Carolina Has 3,800- and 4,200-Ft. Cableways

The world's longest cableways have recently been installed by the Champion Lumber Co., at Sunburst and Crestmont, N. C.—having reaches of 3,800 and 4,200 ft. respectively. These are not cableways of the types commonly employed in engineering construction, being logging skidways, but they are all the more of interest to engineers and contractors. This type of cableway was developed several years ago by J. H. Dickinson, Chief Engineer of the Logging Department of the Lidgerwood Manufacturing Co., New York City. It consists of (1) a steel head spar mounted, with engines, drums and accessories, on two steel railway cars, (2) a tail tree—which is only a sturdy tree in an advantageous location, stripped for blocks, and (3) the lines of cable swinging between.

The 4,200-ft. skidway, at Crestmont, has two clear spans—900 ft. from head spar to relay tower and 3,300 ft. from there to tail tree. The 3,800-ft. skidway, at Sunburst, has a single span, but the tail tree is 1,000 ft. higher in elevation than the head spar. In these two installations the head spar is a 75-ft. latticed steel mast, on trunnions for lowering ahead (when the logging operations require a new set up) and with a full swiveled base (the tail-tree block being shifted through any angle up to 360° for a single head-spar position).

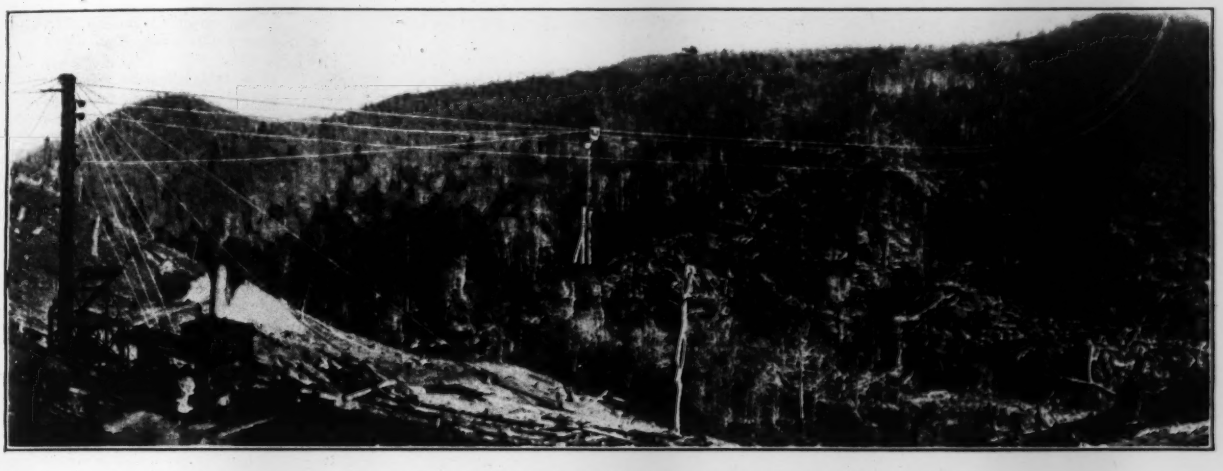


FIG. 1. LOGGING CABLEWAY WITH 3,800-FT. SPAN AT SUNBURST, N. C.

What is called the skidder car has a capacity of 100,000 lb. and carries, on two four-wheel standard-gage trucks, the boiler, skidding and reel engines, and an air compressor for the car brakes. The spar car is also mounted on two four-wheel trucks and carries the head spar and a utility engine for raising the spar. In changing a set-up two extra cars are placed ahead of the spar car—one to carry the spar and one as a spacer.

A 1½-in. cable is swung between the head spar and tail tree, at the spar coming down to a reeling hoist for hauling in or for changing the sag from time to time. On this cable runs a small carriage, as shown in the accompanying views. The skidding cable comes off the outhaul drum on the head-spar car, goes through a block on the spar, out through the carriage and the block on the tail tree, and back to the carriage. From the skidding drum a second cable goes up through a block on the spar and through a block suspended from the carriage. To take up the slack on the skidding line and to bring the end down to the ground (as there is no weight on the end before logs are picked up) a slack pulling cable is hitched to the skidding line, reeved through a sheave on the carriage, run back to a spar sheave and down to a slack-pulling drum. This rigging is shown in Figs. 1 and 2.

The three drums mentioned have slow-speed gears on their shafts, all geared to and driven by a low-speed pinion on the main power shaft. The skidding and outhaul drums are connected to these gears by standard cone friction clutches; the slack-pulling drum has an iron-to-iron floating friction. On the other end of the power and outhaul-drum shafts are a high-speed pinion and gear with a friction between the power shaft and pinion.

The operation of the skidway is as follows: On the outhaul the high-speed gear is used with the outhaul drum, pulling in the line at 2,900 ft. per min.; the skidding and slack-pulling drums are then overhauling. During the next step, the outhaul drum is held on brake while the slack-pulling line is hauled in—overhauling the skidding drum and bringing the end of the skid line to ground. On the third step, after the logs have been hitched on, the skidding drum inhauls at 900 ft. per min., the interlocked outhaul drum paying out its line at the same speed; the slack-pulling drum is overhauling under slight tension.

These cableways were selected by P. C. Thede, General Manager of the Champion Lumber Co., because of the growing difficulty with older equipment of supplying the company's mills with logs (these two mills having a combined capacity of 180,000,000 ft. per year—7.2% of the state's entire lumber production). The Crestmont holdings comprise 55,310 acres, and the Sunburst 35,124 acres. The estimated timber is 1,078,500,000 ft., log scale. The districts are mountainous and have been logged for 15 years, so that all the easily accessible stands have been cut. The best timber is now high up on the ridges untouched.

The character of the country was not such that a 4,000-ft. skidway could be used everywhere, but the saving in many of the set-ups (time lost in relaying track and moving is reduced some 75% over that of 1,500-ft.

FIG. 2. HEAD SPAR AND REEL CARS FOR 4,200-FT. SKIDWAY

cableways) made the largest machines desirable. The Lidgerwood company, which made the skidways, however, conservatively specified that they were to be two-span cableways with only 2,000 ft. per span. It is reported, by the lumber company, that logging with 3,800-ft. span costs less than with the old 1,500-ft. machines, because of greater skidding speed. With the two new high-speed machines and five old slow-speed 1,500-ft. units in operation, the total cost of logging has been reduced about 30c. per thousand.

Government Reports Elaborate Concrete Strength Data

As Technologic Paper No. 58, the United States Bureau of Standards, S. W. Stratton, Director, has just issued a most extensive resumé of the properties of concrete. The title of the bulletin is "Strength and Other Properties of Concretes as Affected by Materials and Methods of Preparation," and it has been prepared by Rudolph J. Wig, Engineer-Physicist, G. M. Williams, Assistant Engineer-Physicist, and E. R. Gates, Assistant Physicist, all of the Bureau. The book, which contains 172 pages, including 38 tables and 44 diagrams, may be obtained from the Bureau of Standards or the Superintendent of Documents, at Washington.

The data presented includes the results of some 20,000 tests. Compressive and tensile tests were made upon mortars at different ages, including about 240 different sands and stone screenings, and compressive tests were made on concretes composed of 60 aggregates, including limestones, gravels, granites, cinders and trap rock, as well as tests of the physical properties of the sands, stone screenings and coarse aggregates. These data furnish information on the range of strength values which were obtained with different aggregates in various consistencies, with variation in workmanship of fabrication, in the method of placing, and in subsequent exposure.

The results of such an elaborate series cannot be given here, but as an indication of the scope of the series there are appended here the conclusions arrived at by the authors. The tabulations and diagrams themselves form one of the most valuable contributions to the knowledge of concrete so far made public. The conclusions are as follows:

PORTLAND CEMENT MORTAR MIXTURES

Sand as a type of fine aggregate cannot be said to be superior to limestone screenings.

The proper gradation of the fine aggregate for maximum strength in a mortar appears to vary for different materials.

The results of the tests of the mortars included in this paper would indicate that for most materials the highest strengths are obtained with those having a gradation of particles approaching a straight line. There are materials, however, having a gradation varying widely from a straight line, which give high strength in mortars.

The quality of a sand cannot be judged from its gradation alone. Any limitation arbitrarily placed upon the proportions of the particles of various sizes will probably eliminate some very satisfactory materials.

No fine aggregate should be rejected because of its "silt" content determined by washing or assuming the material passing the No. 200 sieve as silt, as it may be advantageous even in relatively large quantities or detrimental in small quantities, depending upon its form, character, and distribution.

Mortars having high density usually have high strength.

The quality of sands to be used in cement mortars cannot be determined from their "uniformity coefficients."

There is no difference in the strength developed by rounded and sharp-grained sands.

The quality of sands cannot be determined from their specific gravity and porosity.

Sands having a gradation approaching Fuller's curve for maximum density do not have as great strength as sands having a gradation approaching a straight line.

The only satisfactory method of determining the value of a fine aggregate in mortar mixtures is to test it in the mixture in the proportion to be used, exposed to the same conditions as in the proposed structure.

Common usage has demonstrated that certain sands are satisfactory and therefore no tests of these materials are necessary excepting to identify them.

The relative value of several fine aggregates to be used in concrete cannot be determined by testing them in mortar mixtures. They must be tested in the combined state with the coarse aggregate.

PORTLAND CEMENT CONCRETE MIXTURES

(A) Relation of Type of Aggregate to Compressive Strength—No type of gravel or stone aggregate can be said to be generally superior to any other type used as coarse aggregate in concrete mixtures. Certain limestones are superior to certain gravels, and some gravels are better than other limestones. The range of qualities in any of these types is very great and the strengths of concretes made up of several different materials of the same type may vary as much as several hundred per cent. with all other controllable factors uniform.

(B) Relation of Workmanship to Compressive Strength—Undoubtedly greater uniformity is generally obtained by machine mixing than by hand mixing. The method of mixing is of little importance so long as it results in a homogeneous mass. Using proper methods and with the expenditure of sufficient labor, results indicate that as good concrete can be obtained by hand mixing as by machine mixing, although it probably would not be economical.

With all other factors constant the results included in this paper show that differences in manipulation of the mixture by the workmen of several experienced concrete contractors may cause a maximum average variation in the compressive strength of the resulting concrete of 70% or more.

(C) Relation of Consistency of Mixture to Compressive Strength—The quantity of water added to the mixture in preparing concrete affects materially the compressive strength at all ages. With the proper quantity of water the strength may be several hundred per cent. greater than that obtained with a large excess of water.

The most satisfactory consistency from the standpoint of strength and durability is a quaking or mushy mixture, and the error should be on the side of using too little rather than too much water, providing it is properly spaded or worked into place in the forms. This statement does not apply to the very dry mixtures used in the manufacture of concrete blocks, etc. In the case of these products the mixture should contain the maximum quantity of water which will permit of the immediate removal of the molds. This latter mixture has less water than the quaking consistency described above.

(D) Relation of Density to Compressive Strength—With the same aggregates and the same proportion of cement to total volume of aggregate the mixture having the greatest density will have a high and usually the highest compressive strength.

Density is no criterion of compressive strength of two mixtures of an aggregate if the ratio of cement to total volume of aggregate is not the same.

Density is no criterion of compressive strength of two mixtures of the same proportions of cement to total aggregate if different aggregates are used, although when the aggregates are quite similar they may be comparable.

(E) Effect or Various Exposures on Compressive Strength—The character of the exposure of the concrete after molding materially affects its compressive strength. If the original water is permitted to evaporate from the concrete and all water is subsequently excluded, the compressive strength may be reduced 40% or more. Concrete should preferably be kept wet for several days or weeks after it is deposited if the maximum strength is to be attained.

(F) Effect of Exposure to Steam on Compressive Strength—Steam greatly accelerates the hardening process and will increase the strength of concrete only a few days old by several hundred per cent, depending on the temperature and duration of exposure.

(G) Relation of Gradation of Aggregate to Compressive Strength—There is no definite relation between the gradation of the aggregate and the compressive strength which is applicable to any considerable number of different aggregates.

The gradation curve for maximum compressive strength, which is usually the same as for maximum density, differs for each aggregate.

The so-called maximum density curve, which is a combination of the straight line and ellipse, does not represent the curve for maximum density excepting for the particular materials used in the tests from which it was derived, or very similar materials.

No equation for a gradation curve, which can be applied to a number of different aggregates, can be prepared from the results included in this paper.

Maximum density and maximum strength are usually obtained with a concrete in which the ratio of fine to coarse aggregate is not less than 1 to 3. This mixture is usually quite stiff and therefore more difficult to handle than a mixture containing a larger percentage of fine aggregate.

Excessive fineness does not necessarily result in a totally unsatisfactory sand for concrete. A seashore sand having 99% passing a 50-mesh sieve, when mixed with a good coarse aggregate and cement, was found to give a satisfactory concrete.

(H) Relation of Proportions to the Compressive Strength—With the relative volume of fine and coarse aggregates fixed the compressive strength of a concrete increases directly as the cement content but not in a proportionate ratio. An increase in the ratio of cement to total fine and coarse aggregates when the relative proportions of the latter are not fixed does not necessarily result in an increase in strength. For example, a concrete mixed in the proportion of 1 part cement to 9 or 10 parts of total fine and coarse aggregates combined so as to give a maximum density may have greater strength than a concrete mixed in the proportion of 1 part cement to 6 parts total of the same fine and coarse aggregates, which are not combined to give a maximum density.

GENERAL CONCLUSIONS FROM THE TESTS

1. No standard of compressive strength can be assumed or guaranteed for concrete of any particular proportions made with any aggregate unless all the factors entering into its fabrication are controlled.

2. A concrete having a desired compressive strength is not necessarily guaranteed by a specification requiring only the use of certain types of materials in stated proportions. Only a fractional part of the desired strength may be obtained unless other factors are controlled.

3. The compressive strength of a concrete is just as much dependent upon other factors, such as careful workmanship and the use of the proper quantity of water in mixing the concrete, as it is upon the use of the proper quantity of cement.

4. The compressive strength of concrete may be reduced by the use of an excess of water in mixing to a fractional part of that which it should attain with the same materials. Too much emphasis cannot be placed upon the injurious effect of the use of excessive quantities of water in mixing the concrete.

5. The compressive strength of concrete may be greatly reduced if, after fabrication, it is exposed to the sun and wind or in any relatively dry atmosphere in which it loses its moisture rapidly, even though suitable materials were used and proper methods of fabrication employed.

6. The relative compressive strength of concretes to be obtained from any given materials can be determined only by an actual test of those materials combined in a concrete.

7. Contrary to general practice and opinion the relative value of several fine aggregates to be used in concrete cannot be determined by testing them in mortar mixtures. They must be tested in the combined state with the coarse aggregate.

8. Contrary to general practice and opinion the relative value of several coarse aggregates to be used in concrete cannot be determined by testing them with a given sand in one arbitrarily selected proportion. They should be tested in such combination with the fine aggregate as will give maximum density, assuming the same ratio of cement to total combined aggregate in all cases.

9. No type of aggregate such as granite, gravel or limestone can be said to be generally superior to all other types. There are good and poor aggregates of each type.

10. By proper attention to methods of fabrication and curing, aggregates which appear inferior and may be available at the site of the work may give as high compressive strength in concrete as the best selected materials brought from a distance, when the latter are carelessly or improperly used.

11. Density is a good measure of the relative compressive strength of several different mixtures of the same aggregates with the same proportion of cement to total aggregate. The mixture having the highest density need not necessarily have the maximum strength, but it will have a relatively high strength.

12. Two concretes having the same density but composed of different aggregates may have widely different compressive strength.

13. There is no definite relation between the gradation of the aggregates and the compressive strength of the concrete which is applicable to any considerable number of different aggregates.

14. The gradation curve for maximum compressive strength, which is usually the same as for the maximum density, differs for each aggregate.

15. With the relative volumes of fine and coarse aggregate fixed, the compressive strength of a concrete increases directly, but not in a proportionate ratio as the cement content. An increase in the ratio of cement to total fine and coarse aggregates when the relative proportions of the latter are not fixed does not necessarily result in an increase in strength, but may give even a lower strength.

16. The compressive strength of concrete composed of given materials, combined in definite proportions and fabricated and exposed under given conditions can be determined only by testing the concrete actually prepared and treated in the prescribed manner.

17. The results included in this paper would indicate that the compressive strength of most concretes, as commercially made, can be increased 25 to 100% or more by employing rigid inspection which will insure proper methods of fabrication of the materials.

Bonds for Levee Construction to the amount of $1,500,000 have been voted by the St. Francis Levee Board, which is in charge of levee building in the St. Francis district of Arkansas near Memphis, Tenn. At the time of the passing of the vote the board thought that the Humphreys bill which recently passed the House of Representatives provided that levee districts and states should appropriate one-third of the amount appropriated by the government, and on that basis they announced that the $1,500,000 so obtained would be added to the $4,500,000 from the Federal government, giving $6,000,000, which would complete the 106 mi. of levee work, all of which would be at a height sufficient to stand the stage of 51 ft. at Memphis. The board then planned to issue one-third of the bonds immediately in order to secure $1,500,000 on the passage of the bill and two similar amounts to be secured as needed thereafter. The Humphreys bill passed the House of Representatives with a proviso that the districts and states should pay one-half of the Federal appropriation. The final outcome of the St. Francis situation depends on the passage of the bill in its completed state.

News of the Engineering World

St. Paul Starts Water-Works Improvement Program

As a start in the series of improvements to the water-works of St. Paul recommended by Allen Hazen, Consulting Engineer, New York City, in 1915, plans have been prepared and bids are to be received on June 5 for constructing two coagulating basins and a covered high-service reservoir. The coagulating basins will be used temporarily as a low-service reservoir. Contracts have already been let for a pumping plant which will deliver water to the high-service reservoir.

Mr. Hazen recommended the construction of a mechanical filtration plant including coagulation basins, a pure water reservoir, an aërator, and wash water reservoir. The Water Commissioners do not consider it practicable to finance the filtration project at the present time, but the need for low-service storage is so great that they concluded to build the coagulating basins planned as a part of the filtration plant and use them as a low-service reservoir until the filtration plant is built.

The two coagulating basins will adjoin the McCarron pumping station, and will have a capacity of 3,500,000 gal. each. In plan they will be 226x228 ft. They will have a flat slab reinforced-concrete cover. For both basins, about 6,600 cu.yd. of concrete will be required.

The high-service storage reservoir will adjoin the present Dale St. reservoir, but will give 15 ft. more head. The new reservoir will have a capacity of 30,000,000 gal., will be 402x432 ft. in plan, with an average depth of 26 ft., and will be covered by groined arch vaulting sodded over. It will require about 19,000 cu.yd. of concrete.

The new pumping plant, for which contracts have already been awarded, consists of two 7,500,000-gal. electrically driven centrifugal pumps. The contract has been let to the local electric company for "the necessary current" to pump 1,000,000 gal. for $4, giving an overall efficiency of the combined pumping unit of 72%. This price is equivalent to about 0.6c. per kw.-hr. The pumping equipment will cost about $7,700 and the building to accommodate it about $7,500.

The Market for Labor in New England

A thorough investigation of the unskilled labor market in the East has recently been made for the Aberthaw Construction Co. by O. R. Rietschlin, head of the company's employment department.

The territory investigated was the New England States and New York State. Unskilled labor in this territory is chiefly performed by men of the Bulgarian, Greek, Italian, Polish and Portuguese races. There was general agreement among the labor agents, steamship agents, immigration inspectors and Italian bankers interviewed that the supply of this labor available will not begin to meet the demand. Unless there is renewed immigration, the shortage of labor before the summer is far advanced will be very acute. Ordinary unskilled laborers will demand and receive 30c. an hour and possibly more.

Joseph Spano, field secretary of the North American Civic League for Immigrants, reported continuous calls from various mills and public service companies for laborers in lots of 50 to 600, but is unable to supply them. William H. Nitz, Inspector of the U. S. Immigration Service at Boston, reported that the only laborers arriving in any quantity are Portuguese. These, however, go mainly to New Bedford, Providence and Fall River, where relatives already have places for them in the mills. Very few Italian immigrants are arriving, and those that come are either under or over military age or men rejected from the Italian army and not fit for heavy manual labor.

Tables compiled from reports of the U. S. Department of Labor show that in 1913 and in 1914 immigrants from southern Italy to the number of about 13,000 per annum arrived in the New England States, and about 26,000 arrived in New York State. Since June 30, 1914, not only has this normal increase in the number of laborers been eliminated, but 22,000 have left New England and 64,000 have left New York. The figures show moreover that there is no immigration from other races to offset this great reduction in the available labor supply from south Italy.

Water-Works Repairs Following San Diego Storm

The heavy rainfall that destroyed the Lower Otay rock-fill dam on Jan. 27, 1916 (see *Engineering News*, Feb. 3, p. 236, and Feb. 17, p. 334) did much other damage to the water-works of San Diego, Calif. The following review of repair work done in April, 1916, taken from the monthly report of F. M. Lockwood, Manager, Operating Department, City of San Diego, is doubly interesting because it gives some idea not only of the repair work, but also of the nature and extent of the havoc the heavy downpour wrought in addition to the destruction of the dam:

The work of reconstructing the water system is progressing, despite the difficulty encountered in transporting materials for repairs. Although the roads are being rebuilt as rapidly as possible, it is still necessary to use burro pack trains to get material to certain sections of conduit between Morena and Dulzura.

Eight miles of road, which comprises practically all of the road between Barretts and the main county road to Campo have been rebuilt. Four miles of ditch between Dulzura Summit and Barretts have been cleared and excavated to a depth of 5 ft. by 4 ft. wide. Extreme difficulty is encountered in clearing this conduit, it being practically buried in places beneath tons of rocks which have to be blasted before they can be removed.

By the latter part of April the three miles of wood-stave pipe line connecting the Upper and Lower Otay reservoirs was completed. Upon turning the water in, however, the cement lining of one of the tunnels cracked for a distance of 300 ft., allowing the water to escape. This caused a delay of another week in getting the water into the city, during which time the work was rushed on an additional 1,250 ft. of pipe

line necessary to make a connection at the filter plant. This additional line was constructed of 24-in. wood-stave pipe, a shipment of which was rushed from San Francisco. The line was completed within a week's time and the water from the Upper Otay turned into the city mains.

The 20 filter tanks at the Lower Otay reservoir were all cleaned, resanded and put in readiness for operation. A General Electric flow meter was also installed at this point. This is a very sensitive instrument, which, in addition to giving a correct registration of the flow of water at all times, will enable us to tell the instant a break occurs in the pipe on either side of the meter.

In Mission Valley, three of the 80-ft. wells were cleaned out and put in readiness for operation again. Another well required 40 ft. of new casing. These wells were completely submerged and filled in during the winter storms, the pumps and motors in some cases being entirely washed away. Four of these motors were recovered, however, and have been dried out and repaired. Preparations are now under way for the installation of an air-lift system in Mission Valley.

Reduce Accidents at Crossings

Accidents at grade crossings have increased 1,000% in the last five years in some parts of this country, according to a committee report presented at the semi-annual meeting of the American Railway Association, in New York City. This increase is of course due largely to the greater use of the automobile. The special committee which considered this question recommended five specific practices, which were adopted by the association. These were:

Uniform approach warning signs.

Uniform color of light for night indication.

Uniform use of a circular disk approximating 16-in. in diameter, with the word "STOP" painted thereon in large letters, instead of the vari-colored flags which are now in use by crossing watchmen or flagmen.

Uniform painting of crossing gates alternate diagonal stripes of black and white (somewhat like a barber pole).

Uniform rules governing crossing watchmen or flagmen while controlling or regulating streets or highway traffic.

Electric Central-Station Men on Engineering Matters

Electric lighting is by no means the only field now covered by the activities of the National Electric Light Association, and at the annual meeting held in Chicago on May 23-26 the President (E. W. Lloyd) announced that in view of the development of other fields it has been proposed to adopt a more appropriate and descriptive name. The association really represents the electric central-station companies, and its interests are in the widest possible development of the use of central-station current for light, heat and power in both industrial and domestic service. Over 3,000 members and guests were registered. The meetings were held in different rooms of the Auditorium and Congress hotels, and the Auditorium theater was given up for an exhibition of electrical apparatus and appliances. In addition to the general meetings there were separate sessions for five different sections: Technical and hydro-electric, electric vehicles, commercial, accounting, and company sections. There were over 20 sessions during the four days. A system of telephones connected the meeting rooms and each room had signs showing the subject under consideration in that room and all the other rooms, the signs being changed from time to time in accordance with telephone instructions as the meeting progressed.

The rating of lamps by the "lumen," or unit of light flux, was recommended as a substitute for the candle-power rating, which is said to be an inaccurate and inadequate indication of the illuminating power of lamps. An objection was made that this might cause trouble in making contracts for street lighting, but this did not seem to be considered seriously.

Some of the reports reviewed the growing use of incandescent lamps for factory, office, and other interior lighting. Also for outdoor lighting, not only in streets but at tennis courts, athletic fields, steamer piers, etc. In the ornamental lighting of streets and parks the use of standards with more than two lamps was regarded unfavorably. This subject also included the lighting of country highways at public expense, a method which has been adopted in several states, mainly by counties but also by townships. This, however, is practically an undeveloped field as yet.

Of special interest was the subject of outdoor lighting of construction work, and a similar problem is the lighting of railway yards, both for efficiency and safety of operation. For yards, the ordinary arc lamps and luminous arc lamps are considered inferior to "flood lighting" by incandescent lamps with projecting devices. This system of lighting has been applied also to the exterior illumination of public buildings, statuary and fountains in parks, etc.

Power and Heating

Several reports dealt with developing the sale and utilization of current, and increasing the use of current by the introduction of various appliances for household, office and industrial purposes. In a paper by Edgar F. Collins on the resistance heater as a load builder, it was stated that many water-power plants can generate steam for heating more economically by electricity than by fuel-fired boilers. Electric heaters can be applied also to furnaces, foundry and annealing ovens, melting pots for babbitt and type metal and glue, drying kilns, etc. Special reports dealt with electrical heating (industrial and domestic), welding, steel-making furnaces, the operation of ice-making plants, and the use of cooking ranges and numerous household devices.

The use of electric power on engineering construction work was dealt with in rather limited style in one report. The applications noted included compressors, hoists, pumps, concrete mixers and wood-working tools. Particulars were given of the plant used at the Kensico dam and the Catskill aqueduct for the new water supply for New York City, and the Mount Royal tunnel of the Canadian Northern Ry. at Montreal.

Electric Transportation Methods

In view of the possibilities of electric vehicles as a field for central-station current, the National Electric Light Association has secured the affiliation of the former Electric Vehicle Association, which latter now constitutes the electric vehicle section. The papers in this section related to passenger vehicles, motor trucks and the small trucks used in factories and for handling baggage and express matter. Road construction, street paving and street cleaning were also touched upon in their relation to increasing the mileage to be obtained from one charge of a storage battery.

The larger question of electric traction for railways was dealt with in the meetings of the Hydro-Electric Section, the point of view being that the supply of current for city and interurban railways and even for electrified

portions of steam railways, is a promising field for central station companies. One committee report discussed energy supply for electrification of steam railways, and advised power companies to keep this in view in planning for future developments.

Generation and Distribution of Current

The report of the Committee on Prime Movers stated that the feature of the past year is the phenomenal increase in size of steam turbines, while condenser development has kept pace with that of the turbines. Of special interest is the remarkable increase in steam pressures. A paper by Robert Cramer stated that while 200 lb. is still considered high-pressure, several turbine units are being built to operate under 350 lb. and boiler pressures up to 500 or 600 lb. seem to be highly probable. In the discussion there was some question as to whether the results would warrant the increased cost. The committee considered that the "boiler horsepower" for rating the power of boilers is practically meaningless and should give place to something better. The method of stating the ratio of boiler horsepower to engine horsepower was discussed also, and W. L. Abbott (Chicago Edison Co.) suggested that such matters should be submitted to engineering societies and boiler makers. A resolution was adopted urging the American Society of Mechanical Engineers to recommend a method of boiler rating which will be logical and usable.

Hydro-electric development was reviewed by T. C. Martin, and protest was made against the movement for government control of projects for the utilization of water power. Such control was strongly opposed also in an address on "Water-Power Legislation" by Henry J. Pierce, of Seattle, Wash. The latter approved the Shields bill as originally passed by the Senate, but objected to the Adamson bill substituted for this in the House.

Concrete conduit was mentioned in connection with underground work. It is said to resist burnouts better than vitrified tile, and the finished cost of 3½-in. circular concrete conduit is about the same as that of 3½-in. square tile conduit. For protection of transformers on 4,000-volt circuits, lightning arresters were recommended on the transformer poles rather than the line poles; arresters at a distance of 1,000 ft. give very little protection. Developments in meters and other electric apparatus were covered in several reports. The U. S. Bureau of Standards was criticized for its rules on overhead construction, which are considered not only unreasonably severe, but tending to check the development of rural lines by the higher cost involved.

The new President is Herbert A. Wagner, President of the Consolidated Gas, Electric Light and Power Co., of Baltimore, Md. The Secretary is T. C. Martin, of New York, N. Y.

A Short Course in Concrete Engineering for manual training and vocational teachers is to be conducted by the Extension Division of the Portland Cement Association in Chicago from June 26 to July 1, 1916. The course is free to supervisors and instructors in manual-training work.

Parts of the Plumbing Ordinance of Lexington, Ky., have been declared unconstitutional by the judge of the Circuit Court. The ordinance provided among other things that each master plumber must pay a license fee of $5 and each journeyman plumber a fee of $1, and that these licenses would be renewed annually upon payment of 50c. The ordinance also provided that only plumbers who had passed an examination as required in the ordinance were eligible to receive a license. This provision the court held to be discriminatory. The ordinance also provided that the salary of the plumbing inspector should be paid from license or registration fees from the plumbers of the city. This provision was also held to be unconstitutional.

Good Water-Works in the Philippine Islands are increasing in favor, according to the Bureau of Public Works in Manila, which, "Commerce Reports" states, is receiving requests from all parts of the islands for the installation of water-works systems. Only 12 municipalities in the Philippines can boast of modern water systems, but the bureau has in preparation plans for six additional systems. At San Pablo the construction of a water-works system was begun about a year ago, and it is now nearly completed. The source of this system is a large spring located in the foothills, the capacity of which is 2,000,000 gal. per 24 hr. They are all gravity systems with the exception of the water-works at Tuguegarao, which includes a pumping plant equipped with Diesel engines.

Lightning Protection for Water Towers was dealt with in a report presented at the meeting of the National Fire Protection Association at Chicago, May 9-11. For a wood tank on a steel tower an air terminal at the apex of the roof is sufficient, with the conductor extending from this bonded to the top of the tower, and a ground rod bonded to the bottom of the tower and extended into the earth. Structures over 60 ft. high should have at least two ground rods. If the roof is of metal, this may serve as the terminal, the conductor being bonded to it. For steel tanks on steel towers only the ground rods are needed. The bonding should be done by soldering one end of the conductor into a threaded brass plug and screwing this plug tightly into a tapped hole in the steel frame.

The Second Annual State-Wide Good Roads Day in Pennsylvania was observed May 25 and according to reports received by Chief Engineer William D. Uhler of the State Highway Department more than 80,000 volunteers worked on roads in the 67 counties of the state. Many carloads of road materials were donated by corporations and public-spirited citizens. In the western counties several thousand men worked on the proposed William Penn Highway, which will connect Philadelphia and Pittsburgh. Governor Martin G. Brumbaugh with other officials inspected work in Cumberland, Perry and Dauphin Counties and the Governor himself donned overalls and guided a plow at several places. The Governor was a farmer before he became an educator and politician and was well able to do his bit.

Water Mains and Fire Hydrants in relation to city planning have been made the subject of a questionnaire by a recently appointed Committee on City Planning of the American Water-Works Association, the chairman of which is E. P. Goodrich, 35 Nassau St., New York City. A half-dozen questions relate to pipe location, and a score or so to fire hydrants. The fire-hydrant questions deal, first, with the relative advantages of hydrants located above and below the sidewalk level and, second, with the location of the hydrants longitudinally or in relation to position in the length of the block, and laterally or with respect to position at the curb line or between the curb and the building line. The committee will doubtless be glad to receive information from nonmembers as well as members of the association. Copies of the questionnaire may be obtained by addressing Mr. Goodrich.

A New Cause for Water Waste—In the operation of model tenements in Cincinnati and in Washington, where water is furnished free to the tenants, it is found that the water bill amounts on the average to about one-eighth the rental. It has also been found that the consumption of water by negro tenants exceeds the consumption by white tenants. A neighborhood visitor called at a colored tenement, and as the door was opened to her she heard the splashing of water in the back of the room where a wide-open faucet was discharging a full stream of water into the sink. The visitor turned off the faucet and said to the colored woman: "Why, Molly, what do you keep the water running for when you are not using it?" "Well, you see, mum," replied the colored woman, "I gets mighty lonesome sometimes and dat ar water a-runnin' is a powerful sight o' company."

Halifax Harbor Work in the construction of the new Ocean Terminals described so extensively in "Engineering News" during the last six months is progressing favorably. The railway is almost completed to grade throughout and the contractors are now trimming slopes and cleaning up subgrade. A large part of the terminal yard in Bedford Basin has been in use for some months past. The sectional hollow concrete quay blocks have been laid for about 1,300 ft. of wall and foundations are ready for about 1,000 ft. more. The diving bell has been preparing foundations at a rate of 80 to 100 ft. per week. The rock dredging in the harbor is practically complete. The placing of mass concrete foundations in the

wet at depths from 45 ft. to 60 ft. below low water is being proceeded with and about 300 ft. of wall foundations have already been successfully prepared in this way. The seats on the top of the mass work to receive the cellular blocks have been prepared by helmet divers. This has been necessary to make time, as the diving bell has been fully employed working night and day on other sections.

New York Is Now the Leading Commercial Seaport of the world, according to statistics just made public by the Department of Commerce. The "Statistical Abstract of the United States for 1915," just issued by the Department, shows imports and exports at New York in the last fiscal year amounting to $2,125,000,000. This is some $200,000,000 greater than the commerce of London. The fiscal year ending June 30, 1916, will show a further great increase in the commerce of New York. The following table shows the imports and exports of New York compared with the four other greatest world ports, the figures being for the latest year available.

Ports	Imports (Millions of dollars)	Exports
New York	931.0	1,193.6
London	1,232.1	696.0
Hamburg	1,084.3	817.3
Antwerp	623.2	588.2
Liverpool	810.0	836.0

Leaky Steel Distributing Mains at Galt, Ont., are said to have contributed to the recent temporary failure of the water-supply of that city. On the evening of Mar. 10, 1916, the Imperial Hotel caught fire. The water pressure failed almost instantly. Assistance was promptly rendered by fire pumps in two different mills, but for more than two hours after the fire started the city pumps were of little or no service, even though many valves were shut in mains nearest the hydrants in use. When the fire broke out, the two centrifugal pumps, run in tandem, were out of commission owing to the fact that the 125-kv.-a. motor which drives them had burned out a few days before and was being repaired. Of the two steam pumps, one was operating when the fire alarm sounded, but it is said that the steam supply is low, so time was lost in getting the second steam pump going. In addition to the pump troubles, the 275,000-gal. standpipe was empty. It is reported that this was due to leaks in steel distributing mains laid a few years ago, including a large main in Ainsley St. These mains had given much trouble, it is said, for the past two years from badly leaking joints and from leaks due to corrosion in the body of the pipe. The day after the fire steps were taken to secure a 250-kv.-a. motor, so the two centrifugal pumps can be run separately hereafter; to replace all the steel pipe with cast iron; and to drill a new well at the pumping station.

PERSONALS

Mr. R. T. Wells has resigned as City Engineer of Parsons, Kan.

Mr. S. K. Titus has resigned as City Engineer of Arkansas City, Kan.

Mr. J. R. Crissey has been appointed City Engineer of Johnstown, Penn. He succeeds Lee Masterson.

Mr. Charles Pratt, formerly City Engineer of Chanute, Kan., has been appointed City Engineer of Erie, Kan.

Mr. G. N. Wood, formerly Assistant City Engineer of Douglas, Ariz., has been appointed City Engineer of Chanute, Kan.

Mr. G. A. Harwood has been appointed Engineering Assistant to the Vice-President of Operation of the New York Central Railroad Co.

Mr. Frank A. Probert, M. Am. Inst. M. E., Consulting Engineer, San Francisco, has been appointed Professor of Mining in the University of California.

Mr. Frank Adams, of the United States Department of Agriculture, has been appointed Professor of Irrigation Investigations in the University of California.

Mr. J. S. Langthorn, M. Am. Soc. C. E., formerly Division Engineer, Board of Water Supply, New York City, has been appointed Deputy Commissioner, Department of Water-Supply, Gas and Electricity, New York City.

Mr. Andrew C. Lawson, M. Am. Inst. M. E., Professor of Geology and Mineralogy in the University of California, has been appointed Dean of the College of Mining in that University.

Mr. H. S. Morse, M. Am. Soc. C. E., Director of the Cincinnati Bureau of Municipal Research, has resigned to take charge of the Department of Public Works of the Detroit Bureau of Governmental Research, recently organized to conduct municipal, state and national government research.

Mr. Howard E. Hyde, M. Am. Soc. C. E., formerly Acting City Engineer of Manila, and for many years Principal Assistant Engineer of the Sewerage System and Street Paving of Havana, Cuba, has resigned his position as Assistant Engineer, Water-Supply Board of Providence, R. I., and will hereafter become actively connected with the firm of Young & Hyde, Inc., Contracting Engineers, Produce Exchange Bldg., New York City, with which he has been indirectly connected for several years.

Mr. William Bowie, of the United States Coast and Geodetic Survey, has been appointed a member from the United States of the Permanent Commission of the International Geodetic Association. Since 1909 Mr. Bowie has been Chief of the Division of Geodesy of the Survey, and in 1912 was one of the delegates from the United States to the convention of the International Geodetic Association at Hamburg, Germany. This association was organized more than 50 years ago for the purpose of securing the cooperation of the European nations in undertaking certain geodetic problems which were international in scope.

OBITUARY

James J. Hill, railroad builder, capitalist and most widely known figure of the Northwest, died at his St. Paul, Minn., residence on May 29, as the result of an infection caused by intestinal trouble. J. J. Hill was born near Guelph, Ont., on Sept. 16, 1838. He immigrated to the United States, reaching St. Paul in 1856. In 1870 he organized the Red River Valley Transportation Co. and began development of the Red River Valley, out of which project grew a syndicate that eventually took over the St. Paul & Pacific Ry.—which later became the Great Northern Ry. In 1901 the Hill interests bought the Chicago, Burlington & Quincy R.R.; and in 1907 the fourteen railways operated subsidiary to the Great Northern were purchased by the latter and operated as a part of the Great Northern system.

Lieut. James Vincent Rockwell, M. Am. Soc. C. E., Civil Engineer in the United States Navy, was killed on May 24, at Pensacola, Fla., where he was training as an aviator. The aëroplane he was piloting dived into the Gulf. Lieutenant Rockwell was born in Indiana and appointed to the service from Iowa. He was 39 years old.

Prof. Webster Wells, who was for 38 years on the teaching staff of the Massachusetts Institute of Technology, died, on May 23, in Arlington, Mass. He was born in Boston, in 1851, and graduated from the Institute in 1873, taking up his life work there immediately afterward. Professor Wells was the author of many standard textbooks on mathematics, which gained him a national reputation.

ENGINEERING SOCIETIES

NATIONAL CONFERENCE ON CITY PLANNING.
June 5-7. Conference in Cleveland. Secy., Flavel Shurtleff, 19 Congress St., Boston, Mass.

AMERICAN WATER-WORKS ASSOCIATION.
June 5-9. Convention in New York City. Secy., J. M. Diven, 47 State St., Troy, N. Y.

SOCIETY OF AUTOMOBILE ENGINEERS.
June 12-16. Summer meeting (cruise on Lake Huron and Georgian Bay). Secy., Coker F. Clarkson, 29 W. 39th St., New York City.

MASTER CAR BUILDERS' ASSOCIATION.
June 14-16. Annual meeting, Atlantic City, N. J. Secy., Jos. W. Taylor, Karpen Bldg., Chicago.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
June 14-17. Eighth semiannual meeting. Cleveland. Secy., I. C. Olsen, Cooper Union, New York City.

RAILWAY SUPPLY MANUFACTURERS' ASSOCIATION.
June 14-21. Convention in Atlantic City. Secy., J. D. Conway, 2136 Oliver Bldg., Pittsburgh.

SOCIETY OF RAILWAY CLUB SECRETARIES.
June 16-17. Annual meeting in Atlantic City. Secy., H. D. Vought, 95 Liberty St., New York City.

AMERICAN RAILWAY MASTER MECHANICS ASSOCIATION.
June 19-21. Annual meeting, Atlantic City, N. J. Secy., Jos. W. Taylor, Karpen Bldg., Chicago.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION
June 19-22. Annual meeting in Charlottesville, Va. Secy., F. L. Bishop, University of Pittsburgh, Pittsburgh.

TRI-STATE WATER AND LIGHT ASSOCIATION OF THE CAROLINAS AND GEORGIA.
June 21-23. Annual convention at Isle of Pines, S. C. Secy., W. F. Stieglitz, Columbia, S. C.

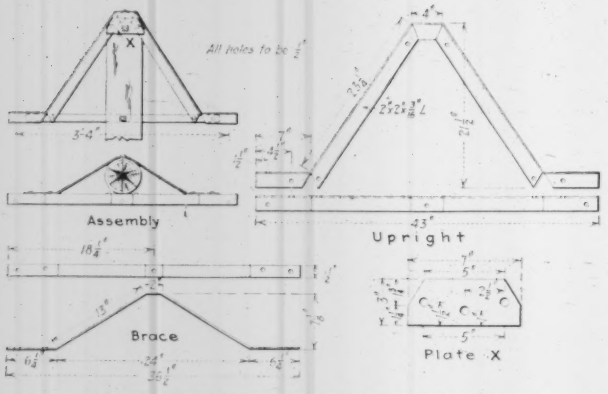
AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 27-30. Annual meeting in Pittsburgh. Secy., Charles Warren Hunt, 220 West 57th St., New York City.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 27-30. Annual meeting in Atlantic City. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Penn.

Appliances and Materials

Steel Crossarm for Power Lines

A simply constructed and easily erected steel crossarm for wood poles on electric-power transmission lines has been devised by E. C. van Diest, Consulting Engineer, Colorado Springs, Colo. It was designed originally for the transmission lines of the Intermountain Railway, Light and Power Co., Holdrege, Neb. It has served the purpose so well that a patent has been applied for. It is now being manufactured by the Associated Engineers Co., Colorado Springs. The accompanying sketch gives the details of this new crossarm.

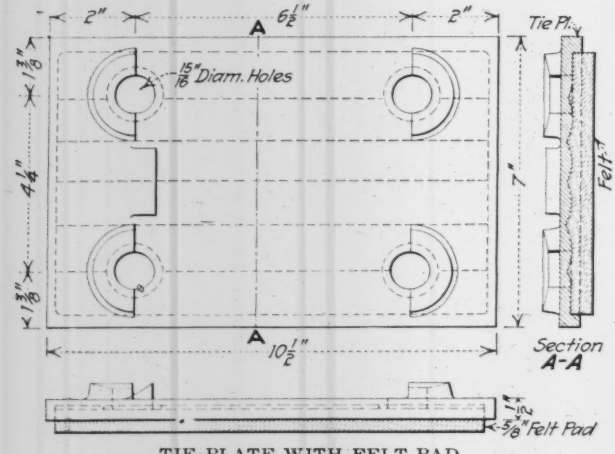


STEEL CROSSARM FOR POWER POLES

* * *

Track Tie-Plates with Felt Pads

To reduce noise of trains in large terminal stations and on elevated railways use is being made of padded tie-plates, having a felt pad between the plate and the tie. The accompanying drawing shows a form of tie-plate having a recess in the bottom to receive the pad and thus hold it securely.



TIE-PLATE WITH FELT PAD

The pad is of cow-hair felt, about ⅝-in. thick. Tie-plates of this design are in use in the electric railway terminal of the Public Service Ry., at Newark, N. J., and on the Chicago elevated railways.

Padded tie-plates in which the pad is simply placed beneath the plate, and not held in a recess, are used extensively at New York City in the Pennsylvania R.R. terminal, the Grand Central Station, and the rapid-transit subways. The use of the pads is mainly to reduce the noise, but they also serve to protect the wood from abrasion, as it is some time before the pad allows the tie-plate to come in contact with the tie. By incasing and holding the pad, as in the design illustrated, it cannot so soon spread or crush down, and its life is thus increased materially. These padded tie-plates are manufactured by the Track Specialties Co., 29 Broadway, New York, N. Y.

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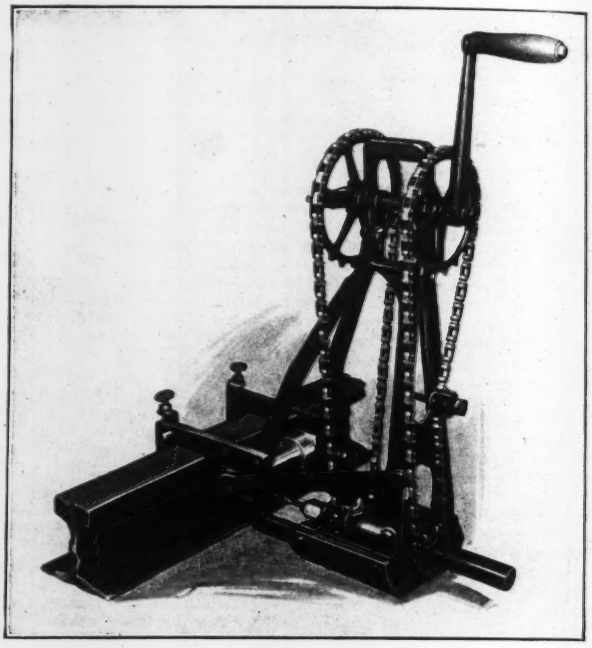
Track-Bonding Drill

The new tool shown herewith is for drilling bond holes in rails. It has no base plate but is secured directly to the rail by clamps which provide for rails of different base widths and heads of different sizes. The clamps grip the rail at two points, and are engaged or released by the movement of a hand lever. The revolution and feed of the drill are effected by two chains with sprockets on a crank-handle shaft. The driving sprocket is disengaged to allow of moving the drill to and from the rail, and an idler is provided for adjusting the tension on the feed screw. An improved chuck and spindle dispense with the need of a setscrew to hold the drill. The machine weighs about 30 lb. complete. It is known as the Buda-Wilson track bonding drill, and is manufactured by the Buda Co., of Chicago.



TRACK-BONDING DRILL

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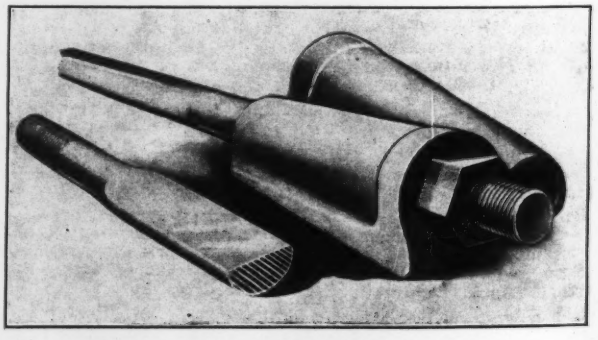
Half-Round Tank Hoops

Tank hoops of half-round section brought out recently by the U. S. Wind Engine and Tank Co., of Batavia, Ill., are shown herewith. This section combines ample strength with a minimum of exposed and inaccessible surfaces. It has a smaller exposed surface than the ordinary wide flat band, and it does not crush the wood or form a dust-collecting gutter (to start corrosion) like a round rod. The lugs keep the ends of the hoops clear of the tank, so that they will not injure the wood.



HALF-ROUND HOOPS FOR TANKS